AIR TRAFFIC MANAGEMENT STRATEGY FOR 2000+

VOLUME 2

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1. Introduction

1.1. The Document

The Air Traffic Management (ATM) Strategy for 2000+ document comprises two volumes:

- Volume 1 provides the basis for, and the background to, the Strategy. It describes the Overall Objective, the high-level principles and major objectives that govern the Strategy, an outline of the main lines of action to effect change, and the general management principles to be adopted.
- Volume 2 - this document - contains the more detailed rationale for change and guidance on the activities that are needed to meet the Strategy objectives. It expands on the material contained in Volume 1, and is set out as follows:

Chapter 1 - provides a short introduction to the document.

Chapter 2 - reproduces the overall Strategy objective, together with the strategic principles and new initiatives described in Volume 1, to provide context.

Chapter 3 - explains why the Strategy and a new approach to providing ATM services is needed.

Chapter 4 - expands on the major objectives described in Volume 1 and provides details of the supplementary objectives and targets.

Chapter 5 - explains how the objectives are related to the operational improvements envisaged and also to the enablers required to support them.

Chapter 6 - describes the main characteristics of the target operational concept towards which the Strategy is aimed.

Chapter 7 - sets out the details of the main lines of action for change in the core ATM and other related processes.

Chapter 8 - details the progressive changes needed to meet the Strategy aims allied to planning horizons for the periods - up to 2005, 2005 to 2010 and 2010 to 2015.

Chapter 9 - provides complementary information related to the management process for the Strategy.

Chapters 10 and 11 - provide details of the reference documents and list the acronyms and definitions used in the document.

Appendix 1 - lists the strategic actions by phase of flight.

Appendix 2 - shows the links between the operational improvements and the key enablers, together with the related benefits.

Appendix 3 - describes the changing roles and responsibilities for pilots, controllers and aircraft operations over time.

Appendix 4 - lists possible economic studies.

The relationship between the Volume 1 chapters and the additional material contained in Volume 2 is shown in the following table:

Volume 1	Related Volume 2 Chapters
Chapter 1	Chapter 1
Chapter 2	Chapters 2 and 3
Chapter 3	No additional material except section 3.6
Chapter 4	No additional material
Chapter 5	Chapter 4
Chapter 6	Chapters 5, 6, 7 and 8
Chapter 7	Chapter 9

Figure 1 : Relationship of Chapters

1.2. Guidance for Future Activities

A number of the changes associated with the Lines of Action and Steps for Improving Performance described in chapters 7 and 8 of Volume 2 require validation and cost-benefit analysis to determine the extent of the benefits that can be realised, and where and how they can best be applied in the European Civil Aviation Conference (ECAC) region. Likewise, the capacity and safety gains that they will bring will depend on the actual performance of the enabling technologies needed to support them.

Validation and cost-benefit analysis will be achieved through focused R&D and the establishment of business cases prior to the implementation of the changes. Volume 1 of the Strategy describes the management processes associated with those aims.

The changes described in Volume 2, particularly in the medium to longer timescales, should be seen as providing guidance as to the most likely path to realise the future uniform European ATM network, based on the best information currently available. It is not proposed to formally adopt them. They will need to be reviewed, and if necessary revised, as newer information becomes available over time. The Strategy management processes incorporate mechanisms for such review.

1.3. Relationship between the Strategy and the Operational Concept

The Strategy document is supported by a related set of technical documents, including the Operational Concept Document (OCD)[1]. The application of the Strategy is inter-related with the operational and functional options described in the Operational Concept Document. While the OCD discusses the main operational and functional options available to realise the Overall Objective of the Strategy, the Strategy provides the criteria for selecting the most appropriate options, and the management principles needed for planning and practical implementation in terms of programmes and projects.

The initial OCD versions were developed by the EUROCONTROL Agency with experts from the ECAC States and other aviation stakeholders, and will be updated by the EUROCONTROL Organisation in parallel with the development of the Strategy. Together, the Strategy and the OCD provide a coherent view of the future European ATM network.

Both documents will need to be reviewed and revised in parallel to ensure that they remain congruent.

[1] **The most current version of the Operational Concept Document (OCD) is Issue 1.1 dated August 1998.**

2. The Main Features of the Strategy

The main features of the Strategy are described in Volume 1. They are reproduced in summary below, together with the Overall Objective and Strategic principles, to show the context in which the Volume 2 material has been developed.

2.1. Overall Objective

The Overall Objective establishes the framework within which to develop the uniform European ATM network for the first decades of the next Century:

For all phases of flight, to enable the safe, economic, expeditious and orderly flow of traffic through the provision of ATM services which are adaptable and scaleable to the requirements of all users and areas of European airspace. The services shall accommodate demand, be globally inter-operable, operate to uniform principles, be environmentally sustainable and satisfy national security requirements.

2.2. Strategic Principles

To achieve the Overall Objective, certain principles shall be systematically applied throughout the European ATM network, during the life-cycle of all ATM projects.

Some aspects of the principles may be quantified as measurable objectives. Other aspects may not be quantifiable, but must nevertheless provide clear guidelines.

The following Strategic Principles shall be applied:

2.2.1. ONE AIRSPACE

The Airspace of the ECAC States shall, for ATM purposes, be considered a continuum and shall not be constrained by national boundaries. The planning, operational division and use of the airspace shall reflect this principle.

2.2.2. SAFETY

Safety is of the highest priority in aviation, and ATM plays an important part in ensuring overall aviation safety. Uniform safety standards and risk management practices shall be applied systematically to the European ATM network.

Within the total aviation safety system approach, an ATM safety regulatory regime shall be established, the functions of which shall be separated from service provision both at European and national level.

ATM safety objectives shall be established and safety performance shall be monitored.

2.2.3. ECONOMY

ATM activities and services shall be economically sustainable for the users. The direct and indirect ATM-related unit costs - which include service provision, delays, flight efficiency and equipage costs - shall decrease in the future. Economic performance can be quantified; objectives shall be established and monitored.

2.2.4. FREEDOM OF MOVEMENT AND SERVICE QUALITY

All airspace users shall have maximum operational freedom within the scope of the other principles, and shall receive services of a nature and quality which satisfy their requirements. Performance targets shall be defined and monitored.

2.2.5. SOVEREIGNTY

Every State has complete and exclusive sovereignty over the airspace above its territory in accordance with international conventions.

2.2.6. NATIONAL SECURITY AND DEFENCE REQUIREMENTS

The ATM network shall satisfy national security and national and international defence requirements.

2.2.7. ENVIRONMENT

The environmental impact of aircraft noise and gaseous emissions shall be taken into account when defining operational ATM improvements. The implementation and application of Communications, Navigation and Surveillance (CNS) and ATM measures associated with such improvements should provide environmental benefits wherever possible.

2.3. New Initiatives

Key new initiatives at European level incorporated in the Strategy include :

- the management and use of the airspace of the ECAC States, as a gate-to-gate continuum for ATM purposes, not constrained by national boundaries;
- enhanced uniform safety standards, practices and safety regulations;
- a regulatory framework to provide effective and timely common rules governing ATM service application and provision by all States;
- cost-effective seamless ATM services tailored to users' requirements and allied to monitored performance targets;
- cost reduction through improved operational efficiency and the optimising of the structure and organisation of service provision;
- concurrent enhancement of air traffic control, airspace and airport capacity as elements of a complex integrated network;
- collaborative decision-making involving all partners based on improved information management and data communications;
- an effective management structure and process to fulfil in a co-ordinated way both pan-European and local implementation needs;
- recognition of the importance of the environmental impact of aviation;
- decision-making processes and incentive options for delivering early and lasting ATM performance improvements;
- early encouragement of the effective contribution and commitment of people in all aspects of ATM as one of the key factors for change;
- measures to strengthen and further enhance civil-military co-operation.

3. The Need for Change and Main New Initiatives

3.1. A Uniform Approach

The ECAC En-route and Airport Strategies for the 1990s led to the introduction of the European Air Traffic Control Harmonisation and Integration Programme (EATCHIP) and Airport/Air Traffic System Interface (APATSI). These, together with the implementation of the Central Flow Management Unit (CFMU), have helped to improve capacity and efficiency in recent years. EATCHIP, which is now reaching its successful conclusion, has brought a number of benefits, particularly in terms of reducing delays in a period in which there has been a substantial increase in the number of flights in European airspace. Despite the efforts made, much work remains to be done to build a uniform European ATM network capable of optimising resources at a European level.

Traffic levels are expected to continue to rise, and further substantial gains are needed in safety levels and ATM capacity and efficiency to meet the predicted future demand. This requires the progressive introduction of new operational and technical solutions based on an overall top-down and performance-driven systems approach. The changes needed call for a uniform European ATM strategy, based on a consensus within the aviation community on a common goal and evolution path. The benefits of this approach are that:

- there is an effective policy-setting and decision-making framework;
- there is a total aviation systems safety approach for all European airspace;
- environmental requirements are respected;
- National security requirements are fulfilled;
- change is co-ordinated, synchronised and implemented efficiently;
- ATM is viewed as part of a complex integrated network which also incorporates airfield air-side operations;
- ATM is optimised on a European-wide basis for the benefit of all airspace users;
- air and ground infrastructure developments and deployments remain in step;
- ATM services are provided in the most cost-effective way;
- there is a timely application of standards to ensure that the various ATM system elements interface in a seamless and consistent manner;
- there is common systems design, development, procurement and deployment wherever this is beneficial.

3.2. Concerted Action and Commitment Now

Concerted action is required if the capacity and efficiency of the ATM network is to be enhanced while improving safety standards. This is essential to avoid a return to the ATM delays experienced in the late 1980's. The long lead times involved in introducing new air and ground systems mean that all of those involved in aviation in Europe must commit themselves now to a strategy that includes a series of operational improvements together with a supporting management framework.

3.3. An Umbrella Strategy

The Strategy proposal is structured on a systematic, top-down and performance-driven approach, and incorporates the identification and prioritisation of those measures which

will deliver early, lasting benefits for the airspace users[2]. It takes account of likely changes in the aviation environment and associated technology over the next 15 to 20 years, and builds on the work completed or currently underway as part of the ECAC En-Route and Airport Strategies for the 1990s.

The Strategy:

- is aimed at the realisation of a uniform European ATM network;
- incorporates at a practical planning horizon of 2015;
- takes account of existing and planned systems and traffic situations;
- recognises the varying needs of the different ECAC regions.

It is intended to provide an effective framework of change within which National plans can be developed. As such, it should be seen as an 'umbrella' strategy that embraces and co-ordinates the more detailed individual strategies (Safety, Communications, Navigation, Surveillance, etc.) which are being developed.

Aviation and ATM will continue to develop in the future beyond the time-frame of the measures set out in this document. Likewise, while the ATM Strategy for 2000+ described here is assumed to be valid generally for the period up to 2015, it offers a strategic planning framework to progressively extend the time horizon beyond that date.

3.4. Stepped Evolutionary Change

The heart of Volume 2 of the Strategy is a 'roadmap' of change along defined lines of action that lead to implementation of the European target operational concept. The lines of action are based on :

- the definition of performance targets for ATM services based on the needs of the airspace users;
- the stepped introduction of a number of operational improvements within the ATM processes that are designed to:
  - ⇒ meet performance targets and keep pace with the traffic increase while providing tangible and early benefits for the airspace users;
  - ⇒ provide a migration path to the target operational concept;
- the implementation of a number of infrastructure enhancements that enable the operational improvements to be realised.

For reasons of safety, cost and risk containment, the introduction of these improvements has to be based on a process of 'evolution' and not 'revolution'. They must follow a stepped path that builds successively on existing infrastructures, both to enable service providers and aircraft operators to amortise current ATM and avionics investment, and to allow the changes to be validated before their operational implementation. The extent of the existing infrastructure to be retained, and the pressure placed upon it by the transition to new concepts, has to be addressed within the framework of optimising the overall costs and maximising benefits, including safety and the environment.

It has to be recognised, however, that it may not be possible to synchronise changes in the most ideal way because of the varying levels of investment which have been made at different times in the past by each State, and the constraints which affect the deployment of systems both on the ground and in aircraft. The Strategy nevertheless provides a

[2] <Airspace users> is used to denote ALL users of airspace, including State, military, airline, other business and commercial, recreational, etc.

means to minimise the impact of less than optimal deployment timings and maintain the uniformity of the European ATM network from the airspace users' perspective.

The changes introduced have to fit within the parameters of the International Civil Aviation Organisation (ICAO) Communications, Navigation, Surveillance/ATM (CNS/ATM) global strategy, and remain in step with ICAO standardisation plans, to ensure continued inter-operability with other areas of the world. As far as is practicable, they must also take account of the varying needs of the different users of ATM services, and accommodate the differing ECAC regional traffic patterns and conditions.

3.5. The Importance of an Efficient Air Transport System

Economic growth is driving changes in the frequency and pattern of air travel within Europe. European citizens are becoming more mobile, and the number of people travelling by air for business and leisure is continuing to increase steadily. This is leading to an expansion of the air route networks and increased traffic flows, particularly between the regional and major hub airports situated in the capital cities and main tourist destinations, as airlines respond to competition from other modes of transport.

Aviation contributes to economic growth, employment and trade. It is also a pre-requisite for mass tourism, one of the major factors in stimulating economies. Anything that is done to support public demand for air travel and enhance the efficiency of the air transport system while minimising its environmental impact, therefore, will contribute to the economic growth, prosperity and well-being of the European States and their peoples.

3.6. Future Aviation in the ECAC States

Volume 1 presents a scenario describing the development of aviation and its context in the next decades. It does not address the issues of uncertainty and risk inherent in planning. It is the purpose of this short section to do so, although not comprehensively.

The issues are: for each statement about the future, what is the likelihood of its occurrence; what could be the alternative circumstances; and how would the envisaged ATM network be able to adapt to cater for other scenarios or elements. In terms of the first two aspects, the statements describing the proposed scenario address the principal factors influencing ATM. For each of them it is possible to define the range of alternatives, and to build a number of scenarios with consistent sets of statements.

Classical techniques used by the consulting industry lead to the definition of two extreme scenarios which bound the range of those possible. In this respect, the scenario proposed in Volume 1 lies between the two extremes; it expresses confidence in the development of air transport but is not over-optimistic. It also makes use of the experience gained in the recent limited application of these techniques within the EUROCONTROL Organisation.

In order to discuss the third issue, it is useful to make some additional remarks :

- the extreme scenarios are - on the one hand - that of economic recession and a reduced need for mobility, and - on the other hand - that of an even more accelerated development in a free choice environment. Both lead to a number of common features; in particular, the need to master costs and provide customer-oriented and responsive services.
- air transport has suffered chronic delays to which ATM contributes a significant part, in spite of the efforts to adjust the ATM network to the evolution of the traffic demand or to use the most efficient technologies. The Strategy must compensate for this at the same time as it accommodates more traffic. The first results of performance shortfall

analyses, and of studies on the sensitivity of ATM performance at macroscopic level to variations in its dimensioning parameters, indicate that there is an economic advantage in operating with some excess capacity rather than with a capacity shortfall.

These observations support the option retained in Volume 1 as the central assumption for the evolution of ATM. The envisaged regular up-date of the Strategy will be based on the refinement and up-dating of the scenario analysis, both to test its continuing validity, and to propose revised plans if necessary.

Although it is known that economies are subject to cycles, there is no indication at present that the scenario described in Volume 1, which is generally consistent with current economical activities, offers any more risks than other scenarios.

3.7. The Need for New Concepts and Systems

3.7.1. Increasing Demand

The expansion of air transport brings with it problems of congestion and delay, and exerts growing pressures on the existing ATM concepts and procedures. The harmonisation and integration of ATM systems in Europe has, depending on the areas or time periods concerned, reduced or stabilised flight delays due to ATM despite a yearly traffic increase of between 3% and 10% over the past 5 years. However, current forecasts indicate that air traffic movements will more than double by 2015 when compared with those for 1997.

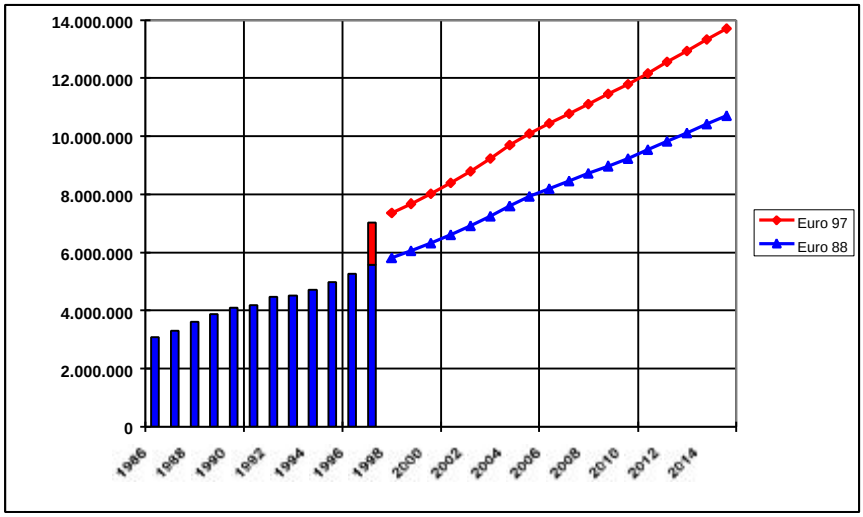

Figure 2 : Traffic Statistics and Forecast for the ECAC Area[3]

Despite the recent successes of EATCHIP, and the measures already in hand to provide further improvements, the current ATM systems and procedures have inherent constraints and will not be able to cope with traffic increases of this magnitude.

[3] Source: STATFOR, DED4 EUROCONTROL Doc. No: 98.70.14 dated June 1998 . Continuous historical traffic data prior to 1997 is available only for the Euro 88 area (Austria, Belgium/Luxembourg, France, Germany, Ireland, Netherlands, Portugal - inc the Azores, Spain - inc Canary Islands, Switzerland and the UK). Data for the Euro 97 area (the Euro 88 area + Cyprus, Czech Republic, Denmark, Greece, Hungary, Italy, Malta, Turkey, Norway, Slovakia, Slovenia and Sweden) is available for 1997 only at present, and both Euro 88 and Euro 97 projected traffic growth figures are shown in the diagram.

3.7.2. Limitations of the Present System

The current ATM concepts and systems have a number of shortcomings. Particular limitations are:

- disparate services and procedures resulting from differing systems, and limited system-support for tools for the controller;
- a reliance on increasingly congested voice radio communications for air-ground exchanges;
- rigid airspace divisions and route structures which are often predicated on national needs, and which do not utilise the totality of European ATM resources to the best effect;
- a lack of collaborative planning between ATM, airport operating authorities and aircraft operators, resulting in less than optimum use of scarce airport air-side capacity;
- limited facilities for real-time information exchange between ATM, airports and aircraft operators, resulting in inflexible responses to real-time events and changes in the users' operational requirements;
- the inability to fully exploit the potential for efficiency and capacity gains offered by aircraft avionics capabilities;
- the long lead-times involved in developing and deploying improved systems in aircraft fleets or in the ground infrastructure which, in turn, result in complex transition planning and high costs. This is exacerbated by the delays encountered in many ATM projects.

A major problem is the current means of airspace sector operations and resultant Air Traffic Control (ATC) workload. An essential component of that workload is the volume of routine air-ground radio communications messages, which in peak traffic conditions can approach saturation point.

Traditionally, capacity gains have been obtained by dividing airspace into smaller and smaller control sectors to off-set the increases in workload generated by additional flights, and this will remain the primary means to increase capacity in the shorter-term. However, this technique follows a law of diminishing returns, as it generates additional co-ordination workload and reduces the ability of sectors to handle traffic situations independently. It has reached its useful limit in some of the busier airspace areas, and other, additional, means have to be found to enhance capacity in the medium to longer-term.

While advances in technology will provide a platform for future capacity and efficiency gains and cost savings, they have to be accompanied by operational change before these benefits can be realised. The best practical path is, therefore, to introduce new concepts and procedures, supported by technological improvements to provide extra capacity, and the types and standards of ATM services that the airspace users require.

3.7.2.1. En-Route ATM

It should be possible to accommodate the forecast en-route traffic growth by introducing new concepts and procedures supported by the exploitation of existing and emerging technologies to the full. This, when combined with enhanced computer facilities, better information management, and a redistribution of responsibilities, will allow ATM to make more efficient and flexible use of finite airspace and human resources, and produce the additional capacity needed to cope with planned air traffic demand under normal conditions.

3.7.2.2. Airports

Airport congestion is already a mounting problem and the limiting factor at some airports. While there are over 800 airports in the ECAC region, 15% of these account for 85% of all commercial traffic. Many of the major airports are already operating at their maximum throughput for longer and longer periods of the day, and some have already reached their operating limits as prescribed by political and environmental constraints.

The forecast increase in demand will exacerbate this problem, and future traffic distribution patterns are likely to spread congestion to other airports that currently do not experience capacity problems.

European and national inter-modal transport policies may influence airport usage patterns, but their impact on the traffic growth rate depends on a variety of issues, such as the completion of trans-European transport networks and environmental parameters. In consequence, these factors cannot be taken into account in this document.

Theoretically, there are sufficient airports and runways in Europe, but since market forces dictate the pattern of traffic, the major airports continue to be bottlenecks, causing not only frustration and difficulties for both passengers and aircraft operators, but also creating severe environmental problems. Particular concerns in this area are the effects of aircraft noise around airports and the extent to which aircraft operations at airports contribute to local air quality problems.

Significant short-term gains could be made by applying the capacity-enhancing measures recommended by the ECAC Airport/Air Traffic System Interface Programme (APATSI), together with best practice. However, the APATSI measures have still not been uniformly adopted or applied by all ECAC States, thus restricting the potential low-cost capacity gains that could be achieved.

New technology, concepts, procedures and systems should be used wherever possible to provide additional air-side capacity and lessen the environmental impact of aviation at airports, but complementary actions such as building new airports or runways will inevitably be required in some parts of Europe if airport capacity is to match the expected passenger demand and the resulting schedules of aircraft operators. There also have to be parallel improvements to air-side and land-side[4] infrastructures and services if the air-side capacity gains are to be fully realised.

The move to private ownership of airports is expected to continue, and to result in a greater emphasis being placed on the commercial aspects of airport operations.

3.7.3. Environment - A New Challenge

Environmental considerations are becoming increasingly important in deciding how and when change should be applied. The aviation industry has consistently tried to lessen the impact of its operations on the environment, particularly by reducing noise and gaseous emissions. This momentum needs to be maintained and accelerated, so that future growth in aviation is acceptable to the citizens of Europe. Improvements in ATM can make a significant contribution through the application of common ATM solutions that deliver reduced delays, shorter and more fuel-efficient routes and, where possible, a reduction in the noise impact around airports.

[4] The term <air-side> is used in this document to denote airport runways, taxiways, aprons and docking gates. It also includes associated activities such as airport air traffic, ground-movement, etc. The term <land-side> is used to denote airport terminals and their operation, including customs, immigration, passenger check-in and handling services. It also includes car-parking facilities, access roads on the airport, etc.

As aviation in Europe is expected to continue to grow, the pressure upon airlines, airports and ATM to increase capacity will intensify the potential environmental impact of aviation. There will, therefore, be a need for measures to manage the environmental impact both at global, regional and local level.

At the global and regional level there will be a need to limit gaseous emissions according to international agreements and national legislation. At the local level, both the air pollution and noise impact will have to be kept at negotiated limits, thus constraining the potential air-side capacity of key airports even further.

3.7.4. Risk of Rapid Growth in Delays

The question of delays in air transport is a complex one. More than 70 causes have been identified among which ATM is just one of a number (airlines, airport, meteorological conditions, etc.). Given that the demand for air travel will continue to grow, both the number of flights subject to ATM delay, and the total ATM delay experienced, will increase unless there is a corresponding expansion in the capacity of the present ATM network, including that of the airports and their surrounding airspace.

Aviation is a dynamic process and it is not possible to eliminate all causes of delay entirely. Neither would it be cost-effective to build an ATM network capable of handling abnormal or infrequent peaks in demand. Nevertheless, the long lead-times needed to implement improvements mean that increases in ATM capacity have to be planned to anticipate the growth in traffic if delays are to be contained at, or below, levels that are considered to be acceptable[5].

3.7.5. Performance Shortfalls

ATM is in essence a network using a number of resources of limited capacity. To accommodate increasing levels of traffic demand, it has to evolve to make better use of scarce resources, or to generate more resources, or resources that are less subject to congestion. As a result, ATM performance, is very sensitive to whether or not the systems functions close to, or at, its congestion ceilings. ATM delays are the visible evidence of these problems, and they tend to grow exponentially when approaching saturation. The preparation of future plans, and the consideration of what would need to be changed or improved, has to take account of :

- the consideration of the potential performance shortfall that would develop if the system was not, or was insufficiently, adapted to the growing traffic demand;
- the analysis of the causes of these potential shortfalls and when they materialise to help eliminate them as far as possible.

Several specific analysis methods are available or are being developed, including simulations, macro-economic modelling and analytical work. The work conducted so far, although it has not yet addressed all of the issues because of the complexity of the problem, leads to a number of converging results:

- they confirm the exponential character of ATM delays when accommodating increasing traffic at constant capacity;
- they show how all improvements, current and past, progressively increased capacity, but have left a chronic overall under-capacity;

[5] Airline schedules normally contain in-built assumptions about average delays times arising from a variety of causes (runway congestion, late boarding, etc.) . The currently accepted figure, given the experienced average delay per flight as a result of the present delay/capacity situation in Europe, is around 10 to 15 minutes.

- they show that, in Europe, en-route ATM is the root cause of nearly half of the ATM delays, but that delays at and around airports are already a larger fraction, and would grow more rapidly, and become predominant once en-route problems were solved;
- they indicate that the optimum functioning point of the network in terms of costs is achieved when the capacity offered is slightly higher than demand, and that costs increase more rapidly when capacity is insufficient rather than in excess. In periods of increasing traffic, this leads to a definite advantage for allowing capacity to grow ahead of demand;
- they show that the situation of the ECAC ATC centres is not uniform, some still have capacity margins, while severe potential shortfalls are predicted for others;
- they indicate that the further use of the technique of splitting sectors to increase capacity (although still a key for the shorter term and a technique that will accompany other improvements) will not accommodate future traffic, and that significant changes in ATM concepts are required to enable phased sector productivity gains (i.e. number of flights that an en-route sector would be able to manage) which have to be achieved by 2015.

4. Objectives and Targets

4.1. General

The top-level strategic objectives that the future ATM network will have to meet are described in Volume 1. They are reproduced here, but have also been expanded to describe their supplementary objectives and targets. However, these descriptions must be considered as tentative pending publication of those proposed by the Safety Regulation Commission (SRC) and the Performance Review Commission (PRC) and approved by the EUROCONTROL Council and General Assembly.

As also stated in Volume 1, traffic levels in the ECAC area vary and not all airspace areas have the same needs or performance requirements. It may therefore also be necessary to set specific time limits for some or all objectives and targets for some or all ECAC regions.

4.2. Safety

4.2.1. General Objective

To improve safety levels by ensuring that the number of ATM-induced accidents and serious or risk bearing incidents do not increase and where possible decrease.

Safety is of the highest priority in aviation. The main purpose of ATM services is to ensure the safe separation of aircraft, both in the air and on the ground, while maintaining the most efficient operational and economic conditions.

European ATM has achieved high levels of safety in the past, and must continue to do so in the future despite increasing demand. This will require improvements in safety management methods.

4.2.2. Enhancing the Safety Management Methods

To ensure safety objectives can be achieved in the most efficient and economic way with minimum adverse effect on operational conditions.

Achieving an increase in the level of safety will present a major challenge for ATM. Assuming that other conditions remain unchanged, the probability of aircraft colliding rises proportionally faster than the increase in the number of flights. This is particularly true at airports and in terminal control area airspace The introduction of more automated functions and integrated networks will place greater emphasis on the safety criticality of their software, HMI and procedures.

Safety objectives must be realistic and take account of the operational requirement. For the purposes of prioritisation and cost-effective application, the methods by which they are achieved must be subject to cost-benefit analyses.

Safety procedures must be improved.

4.2.3. Participating in Global Safety Objectives

To introduce safety tools which encompass all phases of flight from gate-to-gate in line with ICAO policy.

ATM must benefit the framework of global air traffic operations and contribute to the reduction of air transport hazards in line with the ICAO Safety Initiative. Where they provide significant safety benefits, improvements must include measures that address not only collision prevention, but also other significant aviation hazards, such as controlled flight into terrain (CFIT).

While economic and operational factors are often the main drivers behind the introduction of new ATM systems, some equipment can also make a major contribution to improving safety. Assessment of safety benefits should, therefore, form an integral part of any implementation decision-making process.

An implementation plan should be developed.

4.2.4. Improving the Evaluation of the Actual Safety Levels Within Europe

To introduce harmonised ATM safety policy, performance measurement and evaluation methodologies within the ECAC States.

The number of ATM-related accidents is very low and the measurement of ATM safety performance relies mainly on aircraft proximity (AIRPROX) and serious or risk bearing incident statistics. Historically, States have developed their own safety statistics and analyses, and there is no consistent or comprehensive ATM-related incidents and accidents database or uniform statistical analyses performed at a European level. This makes it difficult to achieve a consistent assessment or establish common policy.

There is a need to define common safety indicators for use by all ECAC States. Safety data should be recorded, processed and analysed centrally within the EUROCONTROL Organisation, taking into account the experience of existing national confidential incident reporting schemes.

A proposed action plan should be developed.

4.2.5. Harmonising Safety Regulations

To ensure the clear and separate definition of the respective functions of air traffic service provision and safety regulation by each State at National level;

and

To harmonise the air traffic service regulatory regime at European level within the total aviation system approach to air safety required by the ECAC Institutional Strategy for ATM.

Achieving a harmonised level of safety on the basis of common analysis criteria requires that ATM safety in Europe be regulated and managed in a consistent way, with clearly defined and separate functions responsible at national level for safety regulation and ATM service provision, including safety management. There is also a need to adopt an approach that is in line with ICAO global safety policies. The growing inter-dependency of air and ground systems make it essential that States adopt an approach to safety which is more closely co-ordinated between air and ground than has previously been necessary.

Harmonised safety regulations are a pre-requisite for the introduction of new systems, such as satellite applications. The trend towards commercial operation of air traffic services in several States also demands an approach that separates safety regulation from other ATM functions, especially service provision. Both these factors were taken into account by the ECAC Institutional Strategy, and has led to the creation of institutional arrangements designed to cater for such future developments.

A harmonised safety regulatory framework should be developed.

4.3. Economics

4.3.1. General Objective

To reduce the direct and indirect ATM-related costs per unit of aircraft operations

Economics encompasses aircraft operation and service provision, where service provision covers all gate-to-gate air navigation services. It should be considered in each of the ATM decision-making processes covering the development, implementation, operational and cost-recovery stages, to ensure choices and prioritisation of allocation and best usage of capital and resources.

Costs are of major importance, and cost reduction and value-for-money must be essential elements in the provision of ATM, while still ensuring that levels of safety are maintained. When costs are considered, all component costs should be included. From a service provider perspective, the unit cost is the operations' cost base divided by traffic units serviced by the operations. Only direct costs of operation are included in the cost base. However, to this must be added the indirect costs, which include the cost of delays due to ATM and flight inefficiency. In future, other indirect costs, e.g. environmental costs, may also have to be considered.

The reduction of ATM-related costs, which represent a large component of aircraft operators' operating costs, coupled with the provision of extra capacity, is a key factor to air traffic growth. The expected growth also depends on the ability of aircraft operators to reduce their costs, allowing competitive fares and thus attracting new demand.

There are two frameworks for supporting the primary economic objective of reducing the ATM-related costs per unit of aircraft operation. There are also some additional policies that support direct control of costs and improved efficiency of current operations.

4.3.2. Frameworks

The two frameworks are:

- a performance-driven approach which builds on existing structures and procedures in the EUROCONTROL Organisation;
- a business-driven approach where economic regulation determines the service quality/quantity to be provided, the price charged and the business reward allowed.

Both frameworks may co-exist and the performance-driven approach can be supplemented with a business-driven approach if so decided by individual States.

The proposed objectives presented in the rest of section 4.3 are, therefore, aimed at developing a better understanding of potential economic tools. They do not imply any automatic commitment to apply the results of this definition or development work.

4.3.2.1. Performance-Driven Approach

To develop a system for performance measurement.

The terms of reference of the PRC are to contribute to the effective management of the European ATM network through a strong, transparent and independent performance review and target setting system. The PRC will propose targets for ATM network performance to the EUROCONTROL Council and Assembly for approval, and will monitor these objectives and targets.

It is anticipated that this will result in the following:

- benchmarking of current performance through use of price, quality and quantity of service indicators;
- use of best practices in service provision;
- peer pressure on service providers to comply with targets.

4.3.2.2. Business-Driven Approach

To define economic regulation practices for ATM service provision.

The current arrangements for service delivery are changing. The trends include:

- corporatisation or privatisation within some States;
- partnership between service providers and/or private sector companies;
- cross-border co-operation and service provision;
- use of new technologies which rely on non-ATM service providers;
- increased project risk-sharing in technology development.

It is anticipated that these trends will accelerate the involvement of new providers with potential for further change in the structure and organisation of service provision within a competitive environment. These business processes have the potential to stimulate new investment, and improve productivity and synergy with private sector practices (improved efficiency in sizing and using human and capital resources, improved effectiveness of management and control over service provision). Further development of market access opportunities will continue to be explored by various parties with a view to further contributions by the private sector. The development of market access opportunities will be regulated by the competent authorities.

Where natural monopolies operate there will be a particular need for economic regulation. The role of economic regulation is to avoid abuse of a monopoly position and to ensure that appropriate safeguards are in place for service providers and users, while maintaining a safe and efficient supply of air traffic services both now and in the future.

The aims of economic regulation are to:

- agree the service quality/quantity level to be provided taking account of the financial position of service providers and users;
- agree on pricing principles which provide incentives to ATM service providers to adopt efficient and cost-saving measures.

Economic regulation requires a clear set of regulatory principles and independence of the regulator from the service provider. In addition, transparency of regulatory decisions and good quality consultation between users, service providers and regulators are essential.

To define a “service levels” policy.

The first step in developing "service levels" consists of defining the adequate supply of en-route ATC and associated air navigation services to satisfy existing and anticipated demands by users. The second step consists of establishing economic and operational goals (such as efficiency of the route structure, punctuality, etc.), ensuring that the price charged for the services and their quality is fair and equitable.

To define ways to spread business risk across all stakeholders and provide the opportunity for economic reward.

The development of pricing principles that provide incentives to ATM service providers to adopt efficient and cost-saving measures consists of defining ways to spread the risks of the ATM business between all stakeholders, i.e. the ATM providers, the suppliers, as well as the operators. By participating in the business risk, parties will face the pressure to be more cost-efficient. In such a risk-sharing environment, there should be a reward for business risk-taking. The reward of this risk is usually part of the profit of a company.

This business-driven approach raises issues that require further study, in particular about the evolution of the principles governing the Multilateral Agreement. Appropriate working groups of the EUROCONTROL Organisation should undertake such studies.

4.3.3. Additional Policies

There are policies that could support direct control of costs and improved efficiency of current operations.

4.3.3.1. Pricing management

To review the pricing policy.

A revised pricing mechanism may be needed. This could include:

- pricing that permits a better control over the allocation of costs, target setting for the cost base of charges, better financial management, and the inclusion of a certain margin of risk;
- pricing as a means of traffic flow management;
- pricing to encourage more efficient use of airspace;
- alternative pricing systems for certain parts of the infrastructure, e.g. to provide incentives for early equipage.

The nature of this revised pricing mechanism will have to be worked out as a counter part of the standard service provided to aircraft operators.

4.3.3.2. Co-ordination of the Use of Resources

To improve the co-ordination of the use of resources.

Although there are examples of European co-operation in ATM provision, many services are planned, developed, implemented and operated on a single service State basis. Identification of potential opportunities for co-operation or co-ordination is difficult, and better means of identifying those programmes and projects where co-operation and collaboration would bring benefits are needed. The EUROCONTROL Organisation should monitor the development programmes and investment plans of individual States to identify potential areas of overlap or redundancy, and highlight where a better use of resources could be achieved.

4.3.3.3. Facilitating Financing of Investments

To improve the adaptability of service providers to users' needs through an improved financing system.

The final concept is that of facilitating the financing of the investments needed to move to the new CSN/ATM systems. At times, the inability of service providers to finance new technology is a constraint on ATM. Financing options available to service providers depend on the economic and financial regulations given by the State.

Improved financing should allow service providers the freedom to provide the best system that improves performance for the user.

As for the business-driven approach, these additional policies raise issues that need to be studied, and their implications for all parties need to be identified, and a consensus reached. Appropriate working groups of the EUROCONTROL Organisation should undertake such studies.

4.4. Capacity

4.4.1. General Objective

To provide sufficient capacity to accommodate the demand in typical busy hour periods without imposing significant operational, economic or environmental penalties under normal circumstances.

Capacity is a complex mix of access to airports, airspace and services; predictability of schedules, flexibility of operations, flight efficiency, delay, and network effects. ATM and airspace capacity-related aspects also include controller workload; weather conditions; availability of communications, navigation and surveillance systems, and other factors. The most visible symptom of capacity shortfall is the level of delays.

At present capacity in Europe is determined on an individual basis by airports and ATM service providers.

4.4.1.1. Targets

- to establish mechanisms for appropriately forecasting service demand;
- to determine the unconstrained capacity of the ATM network;
- to provide service capacity to minimise penalties for all users, taking into account the mix and geographical distribution of demand;
- to be able to provide additional capacity increments as determined by traffic forecasts in a cost-effective way;
- to provide capacity flexibility to handle abnormal air traffic situations;
- to optimise the use of resources, including human resources, in order to eliminate ATM-related capacity constraints;
- to allow all users to accommodate and exploit new technology, seeking to harmonise where possible with military developments.

4.4.2. Airport Capacity

To enable airports to make the best use of possible air-side capacity, as determined by the infrastructure in place (land-side and air-side), political/environmental restrictions, and the economical handling of the traffic demand.

Airport capacity is the product of a number of strategic and tactical processes. These include

- capacity planning, harmonisation of operating practices, and infrastructure balance to meet the demand for both passenger and flight movements as long-term issues;
- airport capacity targets, implementation of operational systems and 'best practice' as line management issues.

Good practice for maximising air-side airport capacity must be used in a systematic way across Europe.

Airport air-side capacity indicators must be used more systematically than at present. Regular comparisons must be made between the traffic demand, declared capacity and the unconstrained air-side capacity.

New tools providing decision-making support to all parties in the slot planning process must be developed.

Systems and procedures for improving runway capacity management, in the context of the constraints imposed by the en-route, TMA, ground movement and gate environments are required.

All-weather capacity requires particular attention and the application of measures and new concepts and procedures based on emerging technologies.

4.4.2.1. Targets

- to agree harmonised ECAC methods for establishing airport capacity;
- to form, as required under current European Commission (EC) Regulation 95/93, Local Co-ordination Committees when necessary to discuss inter-related capacity matters and to determine the potential airport capacity at each airport;
- to agree an ECAC-wide requirement for airport-airline-ATC systems to interface with each other in order to achieve effective gate-to-gate flight management;
- to apply best practice at all ECAC airports;
- where beneficial, to close the gap for suitably equipped aircraft between capacity in low visibility conditions and good visibility conditions;
- to seek new techniques and procedures to increase the arrival/departure rate at major airports significantly above the level achieved by systematic application of current best practices and recognised “mature procedures” (based on existing runways);
- to reduce significantly the extra time per flight spent during the taxiing phases compared to the time needed for the same routing if the flight were alone on the airport;
- to seek innovative procedures to enable commuter and general aviation aircraft to be better accommodated at airports.

4.4.3. Access

To enable all users a fair access to airspace, airports and required ATM services.

Access to airspace, airports and ATM services is the first condition to realise a flight. Access to the whole of the airspace under jurisdiction of a State is of vital interest for military or national security missions.

Access can be measured by reference to un-accommodated demand and access denials. The first is not directly accessible to ATM services since it is often, de facto, hidden in airport slot allocation mechanisms and flight scheduling. The second relates to flight cancellations, but also to restrictions on access to some portions of the airspace and airports by certain categories of users, permanently or at specified times. This may also be tied to a minimum airborne equipment set.

Airport access conditions will remain a local issue.

4.4.3.1. Targets

- to take advantage of the capabilities of the best equipped aircraft, while providing service to the least equipped aircraft, without imposing unnecessary access restrictions;
- where beneficial, to improve access to flight information and air traffic control services;
- to define the harmonised safety, capacity and cost-effectiveness criteria to set access conditions;
- to harmonise use of airspace classes;
- to improve flexibility in airspace use and airspace management to minimise the effect of access restrictions to those times where it is needed on safety or capacity grounds.

4.4.4. Delay

To increase overall ATM network capacity in line with traffic demand, to ensure that ATM-induced delays are not a significant constraint, and that the percentage of traffic delayed by ATM is less than today.

Delay is the most visible symptom of capacity shortfall. Good performance indicators are provided by the CFMU. For ATM-related delay, the two indicators useful to aircraft operators are the average delay per flight and the average delay per delayed flight.

In addition to the ATFM indicators supplied by the CFMU, the Central Office for Delay Analysis (CODA) has started to define indicators covering the different sources of delays, but indicators must be improved to complement the European view of all the components of the air transport delays.

4.4.4.1. Targets

- to contain the level of ATM-related delays to an acceptable level in normal circumstances (i.e. excluding heavy peak periods, adverse weather and system failures);
- to reduce significantly the average ATM-related delay per flight;
- to reduce significantly the documented or predicted ATM delays exceeding 15 minutes;
- to reduce ATM-related delays in the longer-term by providing more capacity, so that their marginal cost is comparable to that of not using available capacity.

4.4.5. Predictability

To improve the predictability of flight operations by reducing ATM-related variations in gate-to-gate transit times.

Predictability is essential to build and maintain flight schedules. ATM capacity shortfall has two effects: systematic delays extend artificially the flight duration and require additional aircraft for the same programme; variance on the day disrupts schedules. The

airlines incorporate “padding” for systematic delays in their flight schedules to minimise the effects of the variance on the day. Hub operations are particularly sensitive to predictability problems.

Predictability can be measured in terms of variance/slippage from expected schedule times due to operational, weather, ATM, etc. Indicators are, in theory, available from airlines; the variance factor is measurable using delay distribution data.

4.4.5.1. Targets

- to avoid the need for systematic padding of flight schedules for ATM-related reasons;
- to reduce ATM-related causes of daily variance.

4.4.6. Flexibility

To increase the responsiveness of ATM services to real-time changes in airspace users´ needs.

Flexibility is the ability of ATM to accommodate changing user needs in real time, e.g. leave late, change aircraft, substitute slots. It often equates to operational freedom, and is a means for short-term action to keep flight schedules predictable, whereas predictability is seen as covering longer-term flight scheduling requirements (e.g. crew/resource rostering).

Collaborative decision-making between ATM and aircraft operators is a potential key to optimal fleet control.

Lack of flexibility translates into a “substitution penalty”, measurable via delay data, and the number of denials.

Targets

- to achieve a capacity headroom to allow for flexibility in the network;
- to take into consideration the plans and requirements of each type of operator, including aircraft capabilities and the corresponding flexibility to accommodate real-time changes in operators' intentions;
- to permit aircraft the maximum possible freedom of movement.

4.4.7. Flight Efficiency

To enable all airspace users to operate as efficiently as possible while accommodating both civil and military operators’ needs.

Flight efficiency can be measured as a factor of deviations from the preferred 4D trajectory. Key measures are: excess route length, non-optimum vertical profile, speed restrictions, excess taxi time, and time in the holding-stack.

Optimisation can relate to sets of flights and iIndividual flight optimum is not the top priority for aircraft operators, except for flights which are performed close to the aircraft’s operating range or payload.

4.4.7.1. Targets

- to increase significantly the percentage of flights that are able to follow their preferred flight profiles and schedules;
- to address the fleet optimisation issue in collaboration with fleet operators;

- to reduce significantly documented ATM-induced penalties, such as excess route length.

4.5. Environment

4.5.1. General Objective

To work with ICAO and its member States to obtain improvements in ATM, in particular the accelerated implementation of CNS/ATM concepts, procedures and systems that help to mitigate the impact of aviation on the environment.

The environmental effects of aviation are an increasingly important political, economic and social issue. One of the goals of the Strategy is to accommodate environmental considerations in an integrated and expanded European ATM network. Others are to identify and tackle environmental problems posed by traffic growth, and to progressively improve environmental performance on a network-wide basis.

4.5.2. Supplementary Objectives

To promote the use of new ATM technologies, systems and procedures which benefit the environment or mitigate impact;

To accelerate the implementation of systems improvements that lessen aviation's environmental impact.

To ensure that development and implementation of the Strategy reflects ICAO environmental policies.

It is important to promote the use of new ATM concepts, procedures and systems that bring environmental benefits. This may require improvements to existing environmental assessment methodologies and inventories. Measures taken to increase capacity will help to reduce delays and fuel consumption, thereby reducing emissions at altitude and at and around airports.

ATM delays and inefficient routings increase aircraft noise and gaseous emissions. This is an issue for both airports and en-route ATM. There is broad consensus that there are fuel savings and other positive benefits (such as improved safety, reliability and efficiency) associated with ATM and CNS improvement. While differences exist between the results of studies regarding the scale of fuel savings (and CO_2 and No_x emissions reductions), implementation of these improvements has been estimated to provide potential fuel savings ranging from 1-2% (EUROCONTROL Agency's estimate for the application of free route airspace above flight level 310) to around 15% (order of magnitude estimates for North America only). However, a 1998 United States (US) Federal Aviation Authority (FAA) assessment suggests that potential fuel savings of 6.5% could be achieved in the US national airspace system (and a reduction of 10.7% in No_x emissions) whilst initial estimates by the EUROCONTROL Agency predict fuel savings of 7 to 8% for gate-to-gate direct routes (less if applied within en-route airspace only). It is not known whether and, if so, to what extent, the introduction of capacity and efficiency enhancing measures may result in attracting additional air traffic (and consequently increase fuel burn and emissions). This is referred to as the "rebound effect", but to date there would not appear to be any quantifiable evidence either way.

The Strategy must aim to reduce the ATM-related impact of noise pollution. Efficient ATM should contribute to achieving the targets set for aviation emissions and aim at a global as opposed to regional European solution. This has to be co-ordinated with ICAO on the ATM role regarding the achievement of emission targets. Local noise and emission

pollution at airports is a highly political issue and will be subject to the "principle of subsidiarity".

4.5.3. Targets

- to permit daily aircraft operations in such a way that the impact of ATM-related noise and emission pollution is minimised;
- to support actions which will contribute to reduce noise/air pollution in the vicinity of airports;
- to be compliant with the appropriate international standards, statutory and regulatory requirements in respect of environmental demands.

4.6. National Security and Defence Requirements

4.6.1. General Objective

To determine new mechanisms, criteria and structures to enhance civil-military co-operation and co-ordination.

To ensure access to airspace for military purposes through the implementation of special procedures where necessary.

National security encompasses the maintenance of internal order, measures necessary for the promotion of National interests and, where necessary, deterring or defending against external aggression. Defence, on the other hand, can be defined as the military contribution to National security, including activities in support of international law and treaties and alliances with other States.

States will continue to attach importance to the need for their National security and defence requirements to be safeguarded and improved, whatever the planned developments in ATM. In addition, States may join together and operate to international defence agreements and procedures.

ATM has to support National security in respect of the identification of flights entering a State's National territory; the implementation of air safety measures at all times and under all circumstances in the airspace above a State's National territory and the ability, in times of crisis, for military authorities to resume responsibility for ATM. In addition, ATM also has to support day-to-day military operations, the services for a number of which do not differ significantly from those provided to other airspace users, through the provision of and access to airspace for the military that is sufficient for their needs. It will sometimes be necessary to find compromises to satisfy as far as possible the interests of both civil and military users.

The exchange of both strategic and real-time information between civil and military ATM service providers is essential for civil-military co-ordination, and can only be achieved if civil and military systems are compatible or inter-operable.

The institutional arrangements contained in the ECAC ATM Institutional Strategy stress the need to strengthen civil-military co-operation. The resultant EUROCONTROL revised Convention provides for a number of instruments to achieve this.

The military require sufficiently large areas in which their units can train and make efficient use of their modern weapons systems. Dynamic airspace management using suitable tools must be put in place for the benefit of all civil and military users and simulations are required to validate their efficiency. The concept of the flexible management of airspace

is one such tool, which must be progressively improved as new technology becomes available.

The utilisation of ATM information will be one of the keys to success, and the various objectives can only be achieved by organising the management of the available information within the framework of the defined procedures. In their triple capacity as ATM service-providers, airspace users and administrators, as well as the body responsible for the security of their National territory, the military must have access to any information they might require. Certain protected data will nevertheless need to remain confidential. Such inter-operability has been only partially achieved within each State or between States thus far.

Improvements to civil-military co-ordination have the potential to provide a number of benefits:

- an improved and faster decision-making process in areas involving national and international civil-military interests;
- improved abilities to meet the legitimate requirements of both civil and military service providers;
- compatibility of future civil and military programmes through agreed standards and protocols.

New mechanisms, criteria and structures should be devised.

4.6.2. Targets

- to respect the sovereignty of States;
- to allow States which so request under predetermined conditions to temporarily resume responsibility for all or part of the provision of ATM services in the airspace under its jurisdiction;
- to reliably provide all necessary data for both Air Defence and Operational Air Traffic needs;
- to provide sufficient airspace for day-to-day military operations;
- to maintain or improve the services provided to the Ministries of Defence and North Atlantic Treaty Organisation (NATO);
- to provide capacity to handle crisis situations (contingency plans);
- inter-operable civil and military systems.

4.7. Uniformity

4.7.1. General Objective

To ensure that ATM operations are compliant with ICAO CNS/ATM plans, provide a seamless service to the user at all times, and operate on the basis of uniformity throughout the ECAC area.

Uniformity embodies both the application of common ATM rules and procedures across all European airspace, and the use of common core technical functionality in the systems used. It is not an all-embracing requirement for identical equipment or systems.

Agreed required minimum levels of aircraft equipment, performance and ATM network capabilities will be matched by defined levels of service.

Common rules are an essential feature in meeting the aim of efficient airspace use and managing airspace as a continuum for ATM purposes. There is also a need for uniformity of procedures within ECAC as the basis for, and a means of meeting, service objectives.

Likewise, uniformity of equipage and procedures in Europe cannot be viewed independently from those in the rest of the world. There is also a requirement to harmonise and ensure uniformity in homogeneous regions with similar functionality requirements, and to ensure a smooth transition of flights at ECAC borders. This calls for inter-operable systems and common standards, and for these to be applied extensively to core functions such as flight and radar data processing and communications. Measures of the degree of convergence to be applied have to be developed.

An agreed minimum level of aircraft equipment will be required to enable a satisfactory service to be delivered.

4.7.2. Ensure the Availability of Common Standards

To provide timely standards and procedures for ATM, CNS and associated avionics requirements.

The achievement of the general objective of uniformity needs to be supported by the timely availability of a number of standards beyond the Standards And Recommended Practices (SARPs) set by ICAO. The scope and management of these standards must be tailored to the service requirements, and to the capability of the market to organise itself to elaborate and implement them.

4.7.3. Ensure Cost Effective System Inter-Operability and Evolution

To enable inter-operability between the different elements (aircraft, airport and ATM systems) together with their seamless integration, development and upgrading to new technology.

New ATM concepts will require greater inter-operability between the systems of aircraft, aircraft operators, airport operators and ATM service providers both on the ground and in the air. These systems will evolve at different rates and be replaced or upgraded at different times, but will need to progressively support increasing traffic levels. For a system of a typical life-cycle of 15 years, this means being able to support a doubling of traffic through the smooth evolution of its capabilities.

A key requirement is to specify interface requirement changes well in advance to prevent individual projects being delayed by or being dependent upon these changes. (Interface requirements apply at both the system module level and between national ATM systems.) The specifications must reflect that each service provider will also have systems in place that may continue in service and operate alongside the new systems for many years, and therefore cater for the transition periods.

4.7.4. Targets

- to increase the realisation of common projects wherever beneficial;
- to deliver a service of equal quality throughout the ECAC Area;
- to adopt common standards, specifications and functionalities that will standardise the ATM environment within which all aircraft types can operate. There may, however, be a need to develop particular procedures for some military aircraft to operate within and through these environments;
- to minimise the use of specific local procedures not transparent for airspace users;
- to provide consistency in terms of procedures, systems and structures throughout the ECAC Area;
- to provide inter-operability with adjacent airspace and the military environment;
- to provide a uniformity of ATM services to allow the ATM providers to derive benefits through the use of common standards and equipment as appropriate.

4.8. Quality

To foster, promote and enhance the use of ISO 9000 or similar recognised quality management standards in the provision of gate-to-gate ATM services.

Quality management systems promote business excellence by ensuring customer satisfaction.

4.9. Human Involvement and Commitment

To ensure human involvement and commitment in making possible the changes in future ATM, so that operational, technical and support staff can operate effectively, efficiently and safely within their capabilities, and obtain challenge and job satisfaction.

ATM systems are expected to remain human-centred for the foreseeable future, and people will play a key role in achieving system safety and capacity enhancements. People are an essential element in the ability to deliver ATM services, and their co-operation and involvement in developing and effecting change is essential.

There is, therefore, a need for the timely availability of suitable numbers of people with the right skills, knowledge, attitude and motivation, to assure the expected ATM performance and who are committed to delivering the best possible services.

This involves, firstly, suitable and efficient up-to-date strategies, policies, methodologies, and integrated procedures, together with the requisite tools, for manpower planning, personnel budgeting and recruitment, the selection and training and, if necessary, the licensing of all of the types of staff involved in ATM. Secondly, the extensive and intensive use of human factors principles throughout the whole life-cycle of ATM systems. Finally, it also involves the enhancement of human capabilities in terms of flexibility, motivation, and commitment through the application of suitable human resource

management to ensure that careers in ATM are sufficiently rewarding to attract and retain high-quality staff.

At the same time, human resource measures must be aligned with the strategic principles and other major objectives; this requires the means to measure and monitor parameters such as productivity, cost-effectiveness and efficiency.

The concept of Human Resources is concerned with improving the understanding of human activity and integrating it into the evolving ATM network. It is one of the crucial factors that will enable future operational improvements to be implemented and is a key to commitment for any change and transition. Human Resources activities and projects embrace human resource management, human factors studies and human/technology integration to provide proactive and holistic strategies for the improved use of human resources and evolving technology.

Investment in human resources activities and projects is essential in order to realise the full benefit of human activity in future ATM. The aviation community needs an improved understanding of the added value to encourage common developments and operational applications. Identification and sharing of best practices in the human resources activities that are available in Europe or elsewhere are vital to the completion of the initiatives and programmes.

Development and implementation of human resources programmes in ATM are sensitive issues, and specific cultural and organisational characteristics and differences need to be taken into consideration by involving stakeholders at an early stage to build confidence and keep commitments.

Integration of human activity in ATM development is often seen as increasing costs and time. Measures are needed to integrate human activity throughout the life-cycle of technical systems, both to contribute to implementation within planned timescales and cost, and to increase the acceptability and usability of the evolving technology.

Future work in the human resources area will concentrate on fostering and deepening the integration of human activity in ATM and extending its scope and content. Greater emphasis must be given to the development of human factors methods and human/technology integration, striving for an optimised synergy of human and technical aspects in Europe's future ATM network.

4.9.1. Targets

- development of human factors programmes for individual and team resource management to improve human related safety issues in ATM;
- analysis of current and emerging forms of error, and the development of means to mitigate their impact;
- analysis of human workload and stress, and the development of related strategies to cope with increasing traffic demand;
- analysis of the relationship between human factors and human system integration and safety;
- recurrent analysis of operator tasks, functions and cognitive abilities to prepare for enhanced automation and new forms of task sharing;
- provision of manpower planning data and methods for flexible strategic and tactical planning of operational, technical, systems and support staff to meet future operational and capacity demands;

- recruitment, selection, training and licensing to keep high quality of service provision consistent;
- consideration of social and motivational factors for required transition, change and commitment;
- common development of continuous and relevant training programmes to involve and prepare staff for change;
- continuation training to enhance human capabilities and prepare for appropriate system support and new forms of task sharing;
- development of ATM working methods, positions and systems to increase traffic handling capacity;
- provision of human factors expertise and methods throughout the life cycle of ATM systems to match human and technical capabilities.

4.10. Trade-Offs on Objectives

The simultaneous satisfaction of all user requirements and fulfilment of all the strategic objectives is unrealistic. Conflicts of interest are inevitable, typically for access to the same airspace or runway at the same time, or for the service levels required. The approach proposed in the Strategy is to make sure that the different trade-offs supported by the various classes of users are explicit, and that wherever possible the optimum solutions are selected for all affected airspace users.

The identification and use of trade-offs are based on subtle balances between all of the relevant factors, as illustrated in the following areas described below.

4.10.1. Capacity Vs Costs

Providing capacity at acceptable safety levels is an important objective. The key capacity issues to be resolved are access to airspace and airports (the ability to realise flights), and the ability of some airspace users to respect a schedule (predictability and delay), together with the ability of other users and airports to operate with a degree of flexibility within a schedule framework.

A capacity margin has to be developed to permit flexibility and cope with unexpected events. Providing excess capacity within reasonable limits is less costly than allowing a capacity shortfall generating large delays. This means that there has to be a trade-off between costs and capacity that ensures that any excess capacity generated remains within reasonable limits, and that its costs do not outstrip the benefits that can be realised.

4.10.2. Free Routes Vs Structured Routes

From the view of the aircraft operator, a free route environment offers more efficient and cost-effective routings and reduces the incidence of gaseous emissions, but it can increase ATC complexity and workload. Conversely, structured routes provide a means of designing out recurring traffic problems in high density traffic areas and creating extra capacity. One-way routes in Terminal Control Areas (TMAs), in particular, are a key factor in optimising airspace use and increasing capacity around airports.

4.10.3. Individual Vs Collective Benefit

Airspace users and service providers have different viewpoints concerning the optimisation of individual flights as opposed to optimising the network for the benefit of all flights. However, both regard the overall network performance as the main driver.

Airspace users are strongly opposed to regional synchronised gate-to-gate scheduling as a means of network optimisation, and regard it as a restriction on their entrepreneurial freedom. They advocate that airport scheduling should stay local if possible, rather than becoming a centralised system which imposes restrictions, and that ATM should use collaborative decision-making mechanisms to advise them of the potential consequences of changes to local plans, and the impact that this may have on the network or local capacity available.

4.10.4. Mandating Vs Incentive

Equipment mandating must be used when there is a strong safety case to do so. In this and all other instances, business cases, and early involvement of users, must be used to drive a consensus-building process and deliver early and incentive-led benefits.

It is not possible in all cases to prevent proposed improvements from resulting in an unfavourable cost/benefit ratio for some users. This is particularly true in instances where the mixed mode operations resulting from the partial implementation of a measure would negate the anticipated benefit. System designers should work to limit such occurrences to the minimum. In no case should the safety benefit be negative to any class of user.

This applies particularly to mandating measures affecting airports, who, although part of the ATM network, are still independent business units and have their own financial objectives and targets to meet.

Mechanisms and criteria that include the appropriate incentives must be found to handle those situations that necessarily involve mandating to ensure that timely progress can be made.

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5. From Objectives to Programmes

5.1. Linking Enablers to Operational Improvements and Objectives

For the Strategy to be effective, it is essential to establish the logical connection between the operational benefits and the technical or procedural enablers that support them.

5.1.1. ATM Concepts to Systems Architecture

To enable a systematic design of the overall operational architecture, it is essential to translate the concepts into more specific functional objectives. Progress towards these objectives will normally be in evolutionary stages, each with its own set of benefits and each enabled by some technical or procedural change.

ATM comprises functional processes which act in parallel or in sequence through the various phases of flight, including planning. Performance and quality of service are the result of a complex interaction of these processes.

Priorities for change differ across the ECAC region because the impact of drivers and processes vary. For example, the urgent issues in and around busy airports differ greatly from the needs of low density airspace.

Since the complex interactions between provider and user systems and procedures are broadly similar in sectors and centres with similar traffic, there is an opportunity for joint programmes and projects between ATM providers and users delivering overall efficiency gains.

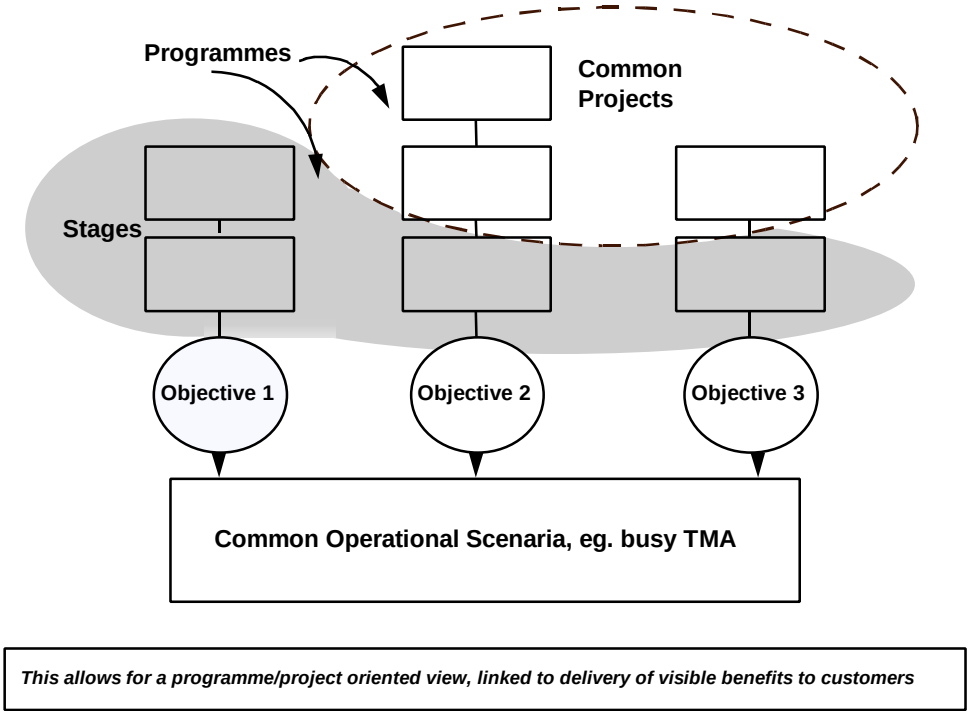

Figure 3 : Individual and Common Programmes

Programmes will be established to embrace related projects such that overall planning is enhanced. Programmes may be local in nature (one centre or State), extended to include multi-lateral arrangements between States, or embrace the whole ECAC region.

Thorough understanding of the way in which trade-offs between potential benefits apply in different locations is essential to the effective statement of each project or programme requirement. The stages in such programmes provide cumulative "stacks" of benefits towards the target concept objectives.

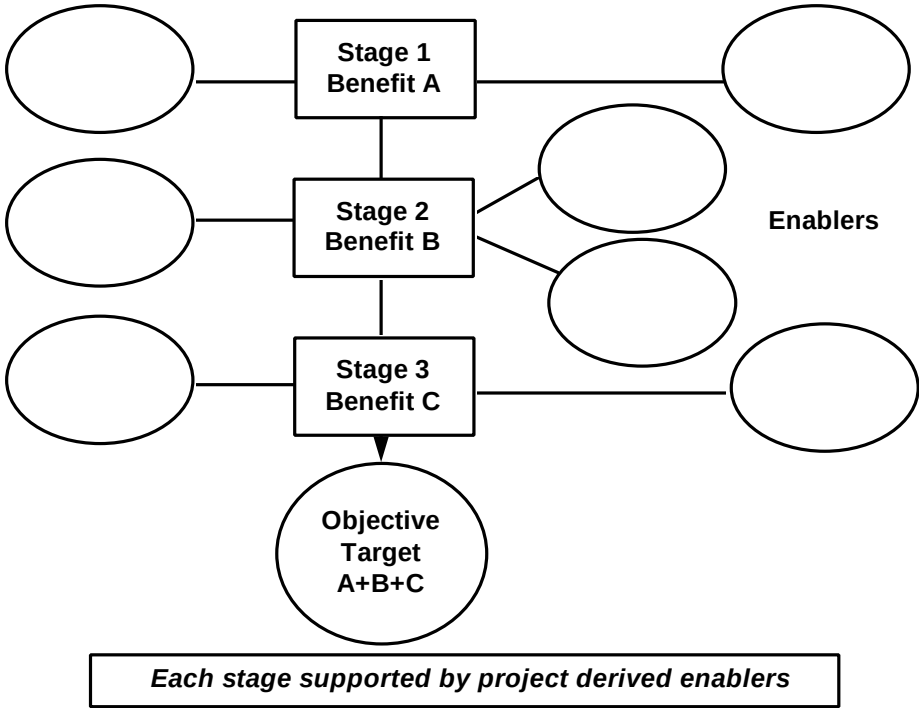

Figure 4 : Benefit Stacks

The combination of enablers comprises a part of the overall action plan but also helps to determine the system architecture. It is the dynamism of this link between evolving benefits and systems changes that provides life to system architecture developments.

5.2. Programmes Aimed at Successful Implementation

A shortcoming of the current regional planning is the absence of clear links between implementation objectives and performance. No European view exists today of what the capacity of the overall network will be in a few years. Information is available at the local level, but there is no consolidated European plan.

The following measures are to be implemented to remedy the situation:

- the programmes required to support the agreed performance targets to be maintained in a consolidated European implementation plan, where information sharing on the current and future needs and capabilities of all stakeholders is key to making right and timely implementation decisions, and to determine and run the most efficient actions in goal-oriented projects;
- implementation management to be based on collective or central activities at the higher planning levels and through adapted working arrangements, followed by actions by the authority responsible for implementation and operations. This includes the practical application of objectives decided by the EUROCONTROL Council and General Assembly based on proposals by the PRC and SRC. The instruments for implementation planning and development are a revised EATCHIP Work Programme (EWP) for

common activities, and the Convergence and Implementation Programme (CIP), which also has to encapsulate airspace user and airborne systems aspects.

- the EUROCONTROL Agency to act as the central planner and co-ordinator for the implementation of these activities, to produce an overall plan that considers the inter-relations between all activities, and directly manage a number of common development activities and common projects. Common CIP Objectives to provide a framework for agreement to local (implementation) activities, at defined target dates, and achievement criteria consistent with overall plans.

The following measures are expected to form part of the solution:

- the rationalisation of objectives, functional changes and evolution to be presented as a Systems Architecture. This will allow the timing, scope and scale of development programmes to be verified in respect of system objectives;
- programmes to be clearly delineated so as to keep them focused;
- the early phases of a project life-cycle to establish clearly the case for change and outline acceptable timetables, including future decision points;
- resources required for implementation, in particular those from States' budgets, to be secured up-front. This includes budget, recruitment, training, and administrative support;
- early pre-operational trials and pilot implementation exercises, including the most fundamental concept paradigm changes, to be carried out in a more systematic way, using opportunities across ECAC, thereby reducing the time from laboratory to real operations and, through emulation, accelerating the dissemination of advanced functions;
- post-implementation evaluations to be performed, based on criteria developed by the PRC.

5.3. Synchronisation

CNS/ATM projects have to be internally synchronised and synchronised with evolving operational needs. In principle, synchronisation is necessary for all phases of the project life-cycle. The synchronisation of the deployment phases of projects is important to ensure that investments can actually be operationally used and that benefits can be obtained. This is of particular importance for the dependencies between airborne systems and ground systems.

The planning of the projects life cycles (from conceptual phase to and including maintenance phase) should take into account:

- the institutional framework which will gradually migrate from the current to the new;
- the political environment;
- the required implementation times for airborne and ground systems;
- the required time for technology to mature and to be validated.

As far as possible, rule-making influencing avionics systems, cockpit procedures and ATC systems should be co-ordinated to reduce the number of retrofit cycles.

5.4. Segmentation

The segmentation model used in this Strategy is a customised high level model derived from the CIP and the EATCHIP segmentation models.

In addition to time, the segmentation model has the following dimensions:

- geographical (based on traffic density and traffic pattern);
- stakeholder;

While segments will have different characteristics, they are part of one integral and seamless environment. Segments are therefore defined to allow the various developments to progress separately but coherently.

5.4.1. Geographical

The geographical scope comprises the whole ECAC area. This area is not uniform in terms of ATC complexity and may therefore have different requirements on, for example, CNS systems, depending on the degree of complexity. The ECAC area is segmented into three areas as shown below. The typical differences between these areas are:

- capacity requirements (resulting from number of aircraft and number of applications);
- technology requirements dependent on remoteness of the area and suitability.

5.4.1.1. High ATC Complexity (H)

The current high-density area of Europe has the characteristics of a High ATC Complexity Area. In such an area, there is typically a high capacity requirement and a CNS coverage requirement from gate-to-gate. Current CNS infrastructures are ground-based and generally dense. Examples of High ATC complexity areas are most of Germany, the Netherlands and the North of France.

5.4.1.2. Medium or Low ATC Complexity (ML)

The Medium or Low ATC complexity areas are currently the South of the Scandinavian countries, South European countries and the East European countries. These areas interface with the high complexity areas and have lower capacity requirements and currently different ATM system requirements. Exceptions are the main airports and TMAs. Use is made of terrestrial and satellite-based CNS systems.

5.4.1.3. Very Low ATC Complexity (VL)

The Very Low ATC complexity areas have a modest traffic level and are typically remote areas. Furthermore, some of these areas have a CNS infrastructure comparable with parts of the North Atlantic (NAT) Region today, i.e. no radar coverage and no line-of-sight CNS systems. In remote VL areas, use is made of HF, satellite systems and independent inertial systems. An example of a Very Low ATC complexity area is the northern part of Scandinavia.

It should be noted that, given the projected growth in air traffic movements, areas classified as ML or VL today may be classified as H or ML respectively in the 2010 and/or 2015 time frame.

5.4.2. Stakeholders

The comprehensive segmentation model developed within EATCHIP identifies all the stakeholders of the European ATM network. In the context of this document, a simplified and limited segmentation has been adopted for the specific purpose of identifying and describing the relations between operational improvements and the main enablers to be implemented :

- aircraft operators;
- airport operators;
- ATM Organisations - public, corporatised or private providers of services;
- regulators (National or European regulatory actions).

It should be noted that the above list does not include all stakeholders.

The airborne requirements are dependent on the area or airspace in which an aircraft operator wants to fly, or on which service he wants to use. The Strategy does not therefore distinguish between categories of aircraft operators unless there is a clear need for it.

Aircraft operators also operate ground facilities, for example, an Operations Centre for the purpose of fleet management. The Strategy is also applicable to the ground facilities of aircraft operators, for example, in the context of collaborative decision-making.

Airport operators are the managers of airport operations; they operate the airport as a (commercial) business providing services to passengers and airspace users, i.e. aircraft.

In this chapter the term ‘airport operations’ is used to describe the activities needed to keep an airport working, except for ATC services.

Different models exist for sharing the responsibilities for the airport-related ATC services, such as ground movement control on runways, taxiways and aprons, approach/departure control, and tower control, between ATMO and airport operators. In the Strategy, this group of functions is considered as being part of the responsibilities of the ATMO and will be provided by an ATMO airport control facility, as at a large number of airports. Airport operators providing airport ATC services are also considered to be an ATMO.

The term airport operator (APO) is used collectively for a number of special interest groups having individual responsibilities in airport operations. These special interest groups include airport authorities, handling agents, customs, immigration, commercial service providers and security.

In order to adequately characterise the ATM evolution at airports, the total set of European airports needs to be classified into broad categories of airports based on movements per peak day and other criteria. The EATCHIP Convergence and Implementation Programme (CIP) identifies the following three classes :

Class	Description	Number of Movements (per peak day)
1	Major airports	400 or more
2	Medium Airports	Between 120 and 400
3	Small Airports	120 or less

Figure 5 : CIP Airport Classes and Number of Movements per Class

Major airports are high-density and very busy airports where scheduled airlines are the major users; examples are London Heathrow, Frankfurt Main, Paris CDG and Schiphol. Medium airports typically have a mix of international and national scheduled and charter flights, and regional flights; examples are Edinburgh, Lyons and Hamburg. Small airports typically have a traffic mix of commercial air transport and general aviation; examples are Bremen, Prestwick and Cork.

In this document the term ATMO collectively refers to the national and supra-national entities that provide the following services:

- air traffic services (ATS);
- air traffic flow management (ATFM);
- aeronautical information services (AIS);
- airspace management (ASM).

Consequently, the ATMO domain also includes the following pan-European entities:

- the Central Flow Management Unit (CFMU), comprising inter alia the Initial Flight Plan Processing System (IFPS) and the Air Traffic Flow Management (ATFM) systems including strategic and tactical systems;
- European AIS Database;
- any other (future) pan-European organisation (e.g. Tri-Partite Group).

The Regulator is responsible for rule-making and for Safety regulations. Deployment planning needs to take into account the time needed for the necessary regulatory processes.

6. The Target Operational Concept

6.1. Re-Examining ATM

To overcome the shortfalls of the present network and provide an effective platform for meeting the objectives means having to challenge current practices with new ideas about how ATM should function in the future. The target operational concept has to find fresh means to reduce ATC workload and enhance capacity, make better and more flexible use of the scarce resources available, and improve the quality, availability and currency of flight information to support more effective methods of collaborative decision-making. This requires both the improved planning of flights on a gate-to-gate basis, and better shorter-term planning and tactical responses using shared real-time information.

6.2. Concept Changes

The future user needs and prevailing aviation and ATM-related trends have led to the definition of an operational concept that focuses on providing extra capacity and improving ATM services. This will be achieved through the combined effects of the six main characteristics listed below, which will work to transform the core ATM processes.

- flight management from gate-to-gate;
- enhanced flexibility and efficiency;
- collaborative decision-making;
- responsive capacity management to meet demand;
- collaborative airspace management;
- extended level of automation and communications support.

These will also contribute to enhanced safety, extend the principles of uniformity and seamless services, and help reduce aviation-related environmental pollution as well as the users' operating costs.

6.2.1. Flight Management from Gate-to-Gate

Gate-to-gate is an expression that describes a wide-reaching perspective of aircraft operations. In addition to its focus on aircraft moving from their gates at origin airports, through their flights, and to their gates at destination airports, it also covers pre-planning for a flight and post-flight activities such as route charge collection. Gate-to gate therefore involves all of the organisations and activities that are directly concerned with the efficient management of flights, not just ATM.

A flight will be considered as a continuum from the departure gate to final destination gate. The primary objective will be for flights to operate as closely as possible to their preferences, from first interaction with ATM and throughout the flight. While each particular phase of flight will be processed within a separate time-frame, the trajectory of the flight (and possibly several flights linked together) will always be considered as a whole.

Gate-to gate can also be viewed as a management approach, founded on the sharing of timely and validated information, that supports better decision-making and flexible responses to events, and requires interaction with a variety of associated activities and functions.

From an ATM viewpoint, gate-to-gate involves the continuous and seamless management of flights throughout all phases of flight. It applies from the first interaction with ATM - which may occur months ahead of a flight as part of the longer-term planning process - to the raising of charges after a flight is completed. The process involves all of the parties - en-route and airport ATC, Aircraft Operators, Airport Operations, etc. - involved in the processing of flights, and is aimed at optimising flight profiles in real-time to provide the best possible service to aircraft and their operators. It also involves making the most efficient use of the ATM network and available resources to benefit all airspace users, which will require some trade-offs between the individual and collective benefits that can be realised.

At present, the extent of the co-ordination that can be effected between the parties involved in the planning and operation of flights is constrained by the inherent limitations of existing procedures and technical systems. These inhibit the exchange of the up-to-date information needed to ensure that all of the parties involved in progressing the flight can react to real-time events and implement timely changes to their plans. The gate-to-gate approach provides for greater collaboration and interaction between the parties, and the extension of the activities of some - such as flow control and airspace management - to reflect real-time events in the management of the ATM network. This will allow ATM, aircraft operators and airports to become more responsive to actual events, and help minimise the current ripple effects that unplanned changes have on the existing ATM network.

The benefits of gate-to-gate will be incremental, and based on the rate of introduction of the supporting procedures and technologies. Full achievement of the benefits of gate-to gate will require early discussion and consensus on areas of responsibility and co-operation, particularly for those aspects where commercial interests must be protected.

6.2.2. Enhanced Flexibility and Efficiency

The basic objective will be that flights operate as intended. The trajectory of the flight will be continually optimised to reflect the best balance that can be achieved at any point in time between the user's needs, the prevailing flight circumstances, and the requirement to ensure both the safety and overall efficiency of the ATM network. This process encompasses external phenomena like weather, airspace availability and capacity/load relationships in the airspace or at airports. The uncertainty on predicted aircraft positions will diminish as the accuracy of the information concerning the flight and the environment in which it takes place is refined over time and exchanged in real-time between the air and ground. This will directly help the controller's conflict diagnosis and reduce the number of tactical interventions necessary. This approach to traffic handling will enhance individual flight efficiency while improving the management of traffic, and support the application of more accurate separation between aircraft.

6.2.3. Collaborative Decision-Making (CDM)

Both the collective requirements of all airspace users and the individual aircraft operator's preferences will be taken into account in determining solutions to events. The open systems environment and better information management will allow a permanent dialogue between the various parties (ATM, Aircraft Operators' Operations Centres, Pilots and Airport Operations) before departure, and as the flight progresses through the ATM network. This exchange of information will enable the various organisations to continuously update each other on relevant events in real-time and provide the basis for more efficient decision-making. Aircraft operators will have up-to-date and accurate information on which to base decisions about their flights, and will be able to apply factors

that are not known to ATM, such as fleet management priorities, fuel consumption figures and other aircraft operating parameters, when determining solutions.

Collaborative decision-making (CDM) allows decisions about events to be taken by those best positioned to make them (e.g. aircraft operators make decisions about their operations; service providers make decisions about ATM resources such as airspace, route structures, etc.). It is an essential element of the gate-to-gate approach to the management of flights.

The collaboration aspect relates to the need for all relevant information to be shared between the parties involved in making decisions. Decision-making follows as a normal operational process, but decisions will be of a better quality and engender greater confidence because accurate and validated information will be available in the right form, in the right places and at the right times.

An open systems environment and better information management will allow information sharing on a much wider basis than hitherto, and support a permanent dialogue between the various partners - ATM, Aircraft Operators' Operations Centres, Pilots and Airport Operations, etc. - throughout all phases of flight.

This exchange of information will enable the various organisations to update each other continuously on events in real-time. Thus, aircraft operators will have up-to-date and accurate information on which to base decisions about their flights, while ATM and airports will have a better knowledge of flight intentions for operational and planning purposes.

There will be a number of other interested parties who need information to improve the service that they supply to - or receive from - ATM, such as customs and immigration authorities, who will benefit from more accurate arrivals and departure information. The combinations of partners involved in any particular decision process are numerous. For example, some decisions will concern just the airport authority and aircraft operators (refuelling times, etc.), whereas others will need to involve all parties (changes to departure times, etc.).

CDM can be considered to be both active and passive, and applies at all layers from longer-term planning activities through to real-time operations. There will be occasions when communication and negotiation between the parties involved will be required to resolve a problem or meet a request for change (e.g. by aircraft operators for the sequencing of their aircraft for operational reasons), but in many instances a decision will be made by just one of the partners based on information supplied by the others (e.g. to fly a particular route to avoid forecast congestion points). An essential pre-requisite is that all participants keep the information for which they are responsible accurate and timely.

6.2.4. Responsive Capacity Management to Meet demand

Capacity will be increased by a variety of inter-related measures founded on improved technology. This will include better and more flexible use of airspace, improved planning based on more accurate and timely flight information, the automation of certain ATM processes, the extensive use of enhanced computer tools, and new or revised procedures between the air and ground, and between humans and machines, governing the current roles and allocation of responsibilities for separation assurance and traffic sequencing. At the same time, flexible mechanisms for capacity management including the dynamic adjustment of routings through under-used capacity areas, sector configuration management, and the dynamic allocation of human resources, will enable capacities to be adjusted to variations in demand. ATM managers will be accountable for capacity provision (within the limits of foreseeable events).

6.2.5. Collaborative Airspace Management

Changes in ATM roles will shift the emphasis of work from tactical to planning activities and airspace sectors will be enlarged. Sector responsibilities for flights will extend over greater airspace areas which stretch across existing boundaries as flights are managed as continuums. This, inter-alia, will lead to collaborative airspace planning and management mechanisms, involving both civil and military authorities for the whole ECAC airspace to ensure that airspace resources are utilised to best effect across the whole region. Airspace will be planned and managed as a common continuous resource, based on user requirements, whenever conditions permit.

6.2.6. Extended Levels of Automation and Communications Support

In order to obtain full benefit, future operational improvements are highly dependent on the support of more sophisticated computer assistance tools and human-machine interfaces (HMI) exploiting higher quality trajectory prediction, data communications and other technical developments.

Details of the strategic objectives and associated strategic actions incorporated in the proposed target concept, together with approximate timings for change, and a rough allocation of costs and likely benefits are given for each phase of flight in Appendix 1.

6.3. The Proposed Changes

6.3.1. Structure for Actions

The next stage is to identify the changes that have to be introduced to provide improvements in:

- ATM functions and processes;
- human resource management;
- the integration of technical systems;
- safety management.

The set of changes through time is expressed in terms of a proposed implementation plan which sets out the guiding principles and main transition steps to provide a feasible and realistic path from today's systems to the proposed target network.

Each of the operational improvements proposed is tied to the forecast availability of the necessary technology and other supporting operational changes, and each provides the foundation for the next operational improvement. It has to be understood, however, that ATM involves a complex interaction between all of its component parts, and that changes in one area are linked to those in some or all of the other areas. Also, that some technical changes support operational improvements in a number of areas.

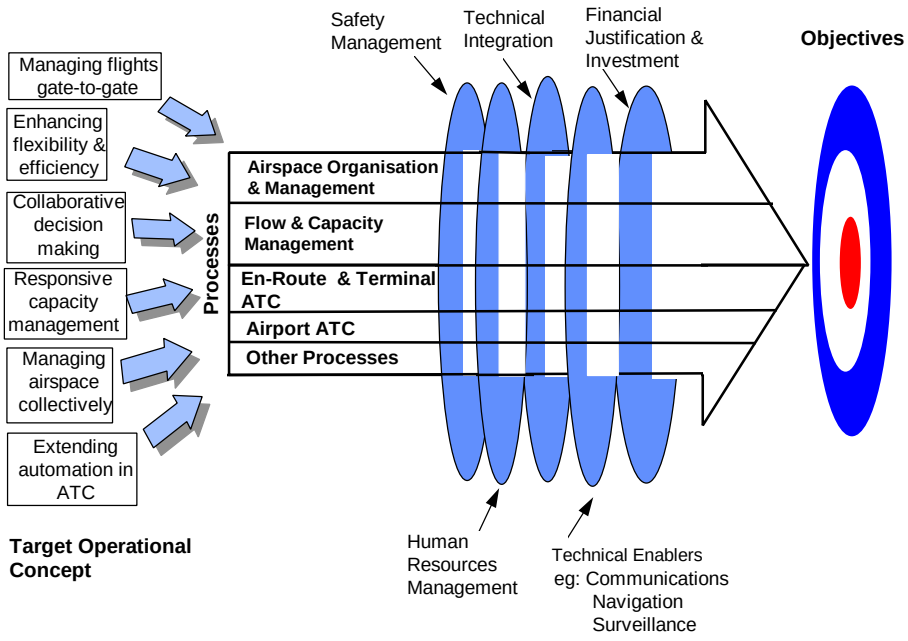

Figure 6 : The structure of actions for change

The proposed changes aim to satisfy the performance objectives. Their implementation will be directly allied to realisable benefits for the airspace users. The timings used represent the point at which particular operational features will become available for use in all, or designated parts, of the European airspace by suitably capable aircraft following any validation and certification periods. The practical problems associated with transition will inevitably lead to different implementation dates for different European areas for some of the changes. It is also inevitable that the necessary changes to aircraft avionics will be spread over time, and that some suitably equipped aircraft may be capable of adopting changed procedures and gaining benefits prior to the predicted implementation date given. Since, in many instances, the full benefits of change cannot be realised until most aircraft are suitably equipped and capable of operating to new procedures, or the size of the airspace in which the procedures are applied is sufficiently extensive, one of the strategic actions will be to ensure that the equipment change and transition periods are as concentrated as is possible.

While the improvements will bring some benefits to all aircraft, aircraft operators who adapt aircraft capabilities to take advantage of each of the operational improvements will gain successively greater benefits in terms of flexibility and more cost-effective operations.

CDM, and the gate-to-gate approach to the management and processing of flights are essential elements of future ATM, and provide an overall context in which to view the operational improvements described later in the document.

6.3.2. Use of Best Current Practice

A number of procedures, functionalities and practices are recognised as providing operational benefits, but are not yet applied widely. A good example is re-sectorisation. Another is the APATSI Mature Procedures, which should be extended to encompass ATM as a whole and regularly updated. A strategic aim is for all involved in aviation to compare their procedures with the best current practices and make best use of them. This will contribute to a more uniform ATM service as well as bringing local service improvements.

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7. The Lines of Action

7.1. Airspace Organisation and Management

The principles underlying the recently adopted Flexible Use of Airspace (FUA) concept [6], advances in avionics and altimetry, and the development of Area Navigation (RNAV) techniques together with satellite navigation systems capable of providing more accurate and timely position information, will provide the cornerstones for progressive improvement in the way that airspace is managed and used. This, together with modelling and simulations of the optimum airspace structures, will lead to the ECAC airspace being regarded as a continuous common resource for ATM purposes.

7.1.1. Flexible Use of Airspace

The FUA concept, adopted by the majority of States in 1996, provides one of the foundations for more efficient management of airspace resources, and for improvements in route structures, by releasing airspace in areas and at times when it was not previously available. This, in turn, will allow the introduction of both additional routes and more direct RNAV routes, thus increasing the capacity of the available airspace and shortening flight distances to some destinations. FUA should have been fully implemented by all States by 1998, and this will provide the basis for further improvements in airspace and route optimisation across the whole of ECAC. Collaborative civil and military airspace planning should be in place in most States by 2005, and will progressively lead to all airspace in Europe being regarded as a continuum under collaborative civil-military airspace planning by around 2010.

7.1.2. Additional Flight Levels

Advances in precision altimetry leading to the planned introduction, in 2001, of Reduced Vertical Separation Minima (RVSM) of 1000ft between aircraft operating in the upper airspace will release a number of additional flight levels. This will increase the physical capacity of the airspace and help reduce traffic complexity by providing more opportunities to vertically separate opposite-direction routes and crossing traffic. It will also allow more aircraft to fly close to their optimum flight level.

7.1.3. Airspace Structure Optimisation

Data communications, the introduction of improved flight plan processing systems, and advanced airspace management co-ordination tools and message exchange capabilities will facilitate a progressively more flexible and dynamic management of airspace. Delegation of ATC responsibilities across Flight Information Regions (FIRs) to address particular traffic confluence or congestion problems at particular times will become more widespread as systems become more integrated. Where traffic densities permit, there will be an evolutionary change from fixed airspace divisions to flexible airspace allocation. The aim is to move to an entirely flexible airspace structure from around 2010, whereby airspace sector boundaries are adjusted to particular traffic flows and peaks in demand in real-time, and are not constrained by National boundaries. Initial considerations will include defined airspace blocks and sector configurations for particular times of the day.

[6] The FUA concept is described in the EATCHIP Airspace Management (ASM) Handbook; Edition 6.1 dated 12 June 1995

7.1.4. Route Network Optimisation

Measures are in hand to improve the present fixed route network to reflect the improved airspace flexibility offered by the FUA concept, and the early use of RNAV techniques. This will help in designing route structures - where such structures are still required - which avoid concentrations of aircraft over congested points, allow more direct and fuel-efficient flights, and the use of by-pass routes to avoid busy traffic areas.

The requirement for all aircraft operating within European airspace under instrument flight rules to be capable of RNAV operations with accuracy levels of Required Navigational Performance (RNP) 5[7] will provide the means to modify route structures by a gradual movement to an all RNAV route environment offering more routes and shorter point-to-point segments. The advent of better navigation performances on-board the aircraft may also provide the opportunity to further optimise route structures.

7.1.5. Terminal Control Area Re-Organisation

The present and on-going re-design and optimisation of the arrival and departure routes used to structure traffic flows around the busier ECAC airports will enhance TMA airspace capacity and increase airport throughput. This will improve flight predictability and efficiency. It will also help to combat some of the environmental constraints around airports by providing a means for aircraft to reach higher altitudes more quickly after take-off, or to remain at higher levels until closer to the airport, although the benefits to be gained in this area will be dependent largely on the users' operating policies.

7.1.6. Free Route Airspace

Free routes based on RNAV operations will be introduced by 2002, starting in the upper airspace areas of a number of States in Europe's core area, where advanced ATC tools will be introduced to support the controller and keep ATC workload at acceptable levels. The extension of free routes will depend on a variety of issues such as traffic complexities, the need to strategically de-conflict arrival and departure traffic flows, and the perceived benefits and costs to the users.

7.2. Flow and Capacity Management

Changes to air traffic flow and capacity management will centre on moving from a flow management based mainly on regulating mechanisms as today, to the essential function of collaborative management of capacities, both en-route and at airports, to best serve the traffic demand. It is recognised that this will still entail flow regulation. The developments will build on the successful implementation of the CFMU, and further enhance its functions and services to maximise the performance of the European ATFM network. This will include developing the tactical element of ATFM to maximise the use of the available capacity, and achieving a closer alignment between the aircraft operators preferences and ATM. Other improvements will focus on extending the choice of alternative routes offered through more flexible routing schemes, integrating ATFM measures to make more efficient use of airport air-side capacity, and developing more effective measures for dealing with unusual situations, such as significant outages in ATM.

Enhancements up until 2005 will concentrate on the continuing development of existing tools and procedures. Improved traffic management tools will allow ATFM to become

[7] Required Navigational Performance is used to indicate that the aircraft's navigation system must be capable of defining the aircraft's position with an accuracy of a stipulated number of nautical miles (in this instance 5 nautical miles) for 95% of its flight time.

more responsive to short-term changes in airspace and provide better information about flight trajectories. Improvements in data networks, and the introduction of air-ground data links, will support more timely information exchanges and better collaboration between the aircraft operators, air crew, airports, the CFMU, and the rest of ATM. An essential enabler is the ability for the CFMU to monitor the evolution of the traffic situation in Europe in real time through the integration of current traffic situational data within ATFM systems and updated flight information.

7.2.1. Improved Re-routing

Refinement of the Initial Integrated Flight Plan Processing System (IFPS) and software upgrades to the CFMU tactical computer system (TACT) to enhance functionality will pave the way for improved re-routing functions by 2000. This will enable the CFMU to offer alternative routes with fewer delays to avoid congestion points and further reduce the need for strategic routing schemes. Airspace users will be given a choice of routes together with indications of the penalties associated with each, allowing them to make informed decisions.

7.2.2. Enhanced Tactical ATFM

Improved algorithms for slot allocation, and the integration of current traffic situation data within ATFM systems, combining ATFM and radar-delivered data to provide a complete picture of predicted traffic will, between 2001 and 2005, improve traffic monitoring capabilities, provide better prediction and avoidance of traffic overloads, and allow the ATM network to adapt more rapidly to significant change in traffic patterns and unexpected events. It will then be possible to better adapt ATFM measures to meet short-term changes in the users' preferences. The aim will be to provide greater flexibility for the users and reduce the number of instances of significant network overload. This should also deliver an increase of capacity during both normal operations and abnormal situations. The development of Flow Management Position (FMP) tools will also further contribute to this objective.

7.2.3. Collaborative Flight Planning

The extended inter-connection of computer systems by 2005 will lead to more collaborative flight planning and provide the platform to improve collaboration between the ATM network, Airports and the Airline Operations Centres (AOCs). This will encompass IFPS development. Airspace users will be able to have a greater say in decisions on those occasions when compromises have to be found between delay, re-routing, or trajectory limitations and costs. This will improve the opportunities to optimise trajectories, help minimise delays and the occasions when additional route mileage has to be flown, enhance fuel loading assessments, and offer more flexible and responsive solutions to the needs of flight operations.

7.2.4. Optimised Capacity Management

The totality of the improvements to flow and capacity management operations will support a progressive shift from managing demand to that of managing the capacity of the ATM network. The extensive use of computer tools and new procedures, together with more complete historical data, and a better picture of short-term events will allow the available airspace, sector and human resources to be used more effectively. This will minimise the need to apply ATFM regulations as en-route capacity will, from around 2008, no longer be a real issue except during abnormal situations. Flow and capacity management will be applied primarily to:

- tactical management of arrival and departure flows - since airport capacity will be more and more the main limitation of the ATM network;
- residual en-route problems;
- planning of traffic densities in support of the enhanced flexibility in airspace design and use.

In the context of longer term co-ordination with the scheduling mechanisms, the CFMU will provide an advisory service to airports and co-ordinators to identify routes where prospective airport slot allocations have the potential to cause congestion in the en-route sectors. Simulation tools could facilitate the modifications to the proposed schedules to minimise the risk of subsequent congestion and delay. This will become even more important to ensure the integrity of flight schedules and connections as aircraft operators expand their tight network operations, e.g. at hub airports.

The majority of the measures needed to facilitate this should be in place by 2010.

There will be a permanent need for ATFM, which is an integral part of the gate-to-gate approach to flights, and a natural step in traffic planning. This will apply in particular to airport air-side capacity, as it is anticipated that airport capacity will remain the weakest link in the ATM network, and the need to apply en-route regulations will be largely restricted to abnormal circumstances before 2010. Together with IFPS, ATFM has been successfully centralised and enhanced with the creation of the CFMU, and there will still be a need for action to be taken at the level of the whole of the ECAC airspace in the longer-term.

7.3. En-Route and Terminal Air Traffic Control

7.3.1. Objective of ATC

The objective of ATC is to ensure a safe, orderly and expeditious flow of traffic. Although the controller's job is much more complex since he/she is active on most ATM processes to a certain degree, this is mainly achieved through monitoring, conflict detection and resolution, and the sequencing and metering of traffic. It is the workload associated with these tasks, and with communicating instructions to pilots by RT, that is the major constraint on further airspace capacity growth.

Future operational improvements will involve the use of enhanced computer processing powers, and more sophisticated computer assistance tools and human-machine interfaces, to provide automated assistance for some routine ATC tasks, and to improve shorter-term planning. Radiotelephony (RT) will be replaced by air-ground data communications, initially as a means of transferring non-critical messages (in terms of both time and safety), but this could eventually be extended to include some critical messages in certain circumstances. The net effect will be to reduce ATC workload and thereby increase the potential capacity of the ATM network. Some of the tools are identified in the following sections. Their development will be progressive and will need to remain in line with the operational needs and the ability of the controllers to fit them usefully within their cognitive control processes at any time.

In addition, there is a need for safety nets involving tools that monitor the traffic situation and trigger alarms when predictions of the evolving traffic situation indicate that safe separation minima or safety parameters are likely to be infringed.

7.3.2. Separation

At present, the responsibility for separating aircraft safely in controlled airspace resides with the ground ATC system. The proposed operational improvements incorporate three methods of reducing the workload associated with this task over time in-line with improvements to technical systems:

- the use of automated tools to assist the controller in planning and tactical decision-making routing tasks and communications;
- the re-distribution of control tasks within sector teams or between controllers within a control centre;
- the transfer of separation tasks under specified circumstances to the cockpit where the safe feasibility and economic benefits to the airspace users can be shown.

7.3.3. Automation of Routine Tasks

7.3.3.1. Initial Automation

Improved surveillance data processing functions, based on down-linked aircraft parameters, as well as new flight data processing functions like Medium Term Conflict Detection (MTCD), will be available from 2002 onwards. MTCD will provide the means to look ahead for periods of around 20 minutes to identify and resolve potential conflicts. This will reduce the ATC workload associated with routine monitoring and conflict detection, and the number of times that ATC has to intervene and change flight profiles to resolve potential conflicts. The performance of the tools will depend to a large extent on the degrees of inter-operability of Flight Data Processing (FDP) systems, and the quality and accuracy of the flight data used for trajectory prediction .

7.3.3.2. Enhanced Automation

The use of air-ground data communications to provide real-time trajectory information in 4D will further improve the accuracy of trajectory predictions. This, together with fully inter-operable FDP systems and more dynamic and accurate environmental information, will provide the means to introduce multi-sector planning procedures, whereby flights will be de-conflicted over greater route lengths and periods of time using the minimal number of manoeuvres. The result will be to further reduce ATC workload, and improve the opportunities for aircraft to fly the most efficient trajectories for longer periods. The requisite ground technical systems, avionics and operational procedures should be available by 2010, and the benefits provided will expand as more systems and aircraft avionics fits are up-graded.

7.3.4. Redistribution of Control Tasks

As a general rule, the present sector control-team organisations used in control centres are based on a planning and an executive (or 'tactical') controller, who are sometimes supported by an assistant. The progressive introduction of enhanced computer-supported control and planning tools, and the impact that these will have on the controller's workload, will provide the basis for re-examining the current organisational model and division of responsibilities so as to maximise ATC productivity and fund capacity increases. There will also be opportunities to reassess the ways in which responsibilities and workloads are organised across groups of sectors, and to introduce multi-sector planning processes, thereby bridging the gap between the consideration of traffic flows at a European level and the control of flights on individual sectors. New control team organisations are dependent on the introduction of specific executive and planning

support tools, such as Highly Interactive Problem Solver (HIPS), and these should be widely available in control centres by 2010.

7.3.5. Transfer of Responsibility and Co-operative Separation

7.3.5.1. Limited Transfer

Suitable airborne surveillance tools such as cockpit display of traffic information (CDTI) are expected to be available in the time frame of the Strategy, and in conjunction with improved navigation facilities, will enable initial and limited delegation of the responsibility for separation from the controller to the aircrew in prescribed circumstances such as in-trail climbs or overtaking on one-way routes. This will lead to a reduction in the ATC workload per flight associated with routine monitoring, conflict search and problem-solving tasks and facilitate greater freedom for flights.

7.3.5.2. Extended Transfer

The introduction of Airborne Separation Assurance Systems (ASAS) by 2015, with look-ahead capabilities of 6 to 8 minutes, will support the extension of delegated separation responsibilities and ultimately allow autonomous aircraft operations. This can be allied to free route operations, evolving towards the introduction of designated airspace where aircraft will fly fuel efficient user-preferred trajectories and separate themselves from other aircraft. The capacity and cost benefits of autonomous aircraft operations in all phases of flight will be evaluated, and safety analysis undertaken, to decide the optimum volume of 'free flight' airspace. However, it is recognised that autonomous aircraft operations are likely to start in airspace with low density traffic.

7.3.6. Implementation of Air-Ground Co-operation

Radio frequency occupancy is currently the limiting factor on further capacity growth in many sectors in the busier airspace areas. In particular, it involves large amounts of time being spent on passing sector co-ordination and frequency transfer messages, as well as requests by controllers for basic flight information from aircraft. RT will be supplemented progressively by air-ground data communications, through which non-critical messages can be sent, leaving controllers more time to plan, monitor and search for potential conflicts.

Departure clearances and ATIS messages have been the first two applications of air/ground data communications. Initial contact and transfer of communications messages will soon be conveyed in this way. Also, actual flight parameters and aircrew preferences will be down-linked, freeing controllers from the need to use RT to obtain such information. The feasibility of transmitting more time-critical messages over air/ground data communications links will depend on improvements in the speed of transmission of these networks.

ATM data communications have the potential to provide innovative situational awareness enhancements on the ground and in the air and to facilitate advanced automation functions. Seen in the context of gate-to-gate operations, these improvements, when validated in terms of operational requirements, safety, and cost-benefits, will contribute significantly to ATM productivity. Inherent in the requirements definition are the corresponding ATM practices and procedures.

Transitional arrangements will make use of the existing infrastructure without early choice of presumptive technical solutions. The aim is to increase productivity through the exchange of data between air and ground and air to air systems, leading to co-operative

ATM where both the aircrew and airline operations are involved in the decision-making process.

The application families which will provide a number of operational services are known as :

- Controller Pilot Datalink Communications;
- Data link surveillance;
- Data link Flight Information Services;
- Co-operative Air Traffic Management services;
- ATS/AOC co-operative services.

7.3.7. Sequencing and Metering

Making full use of the available air-side capacity at the busier airports will become an increasingly important factor in the future. Present concepts rely largely on the availability of reservoirs of aircraft (holding stacks) in the vicinity of airports as a means of maximising landing rates. The sequencing (order of landing) and metering (spacing between aircraft) of flights is the responsibility of the ATC controller, and these processes do not usually take account of the aircraft operators' preferences or priorities.

The future operational concept aims to minimise delay while optimising the use of the available airport resources to the full. Future operational improvements in this area, therefore, focus on the use of computer tools to automate the management of arriving and departing flights at congested airports. This forms part of a chain of improvements to provide an integrated and modular arrival (AMAN), departure (DMAN) and surface management (SMAN) system that will bring benefits in respect of all of the main ATM performance objectives by reducing ATC workload and the effects of congestion.

7.3.8. Automated Arrival Management

Automated arrival manager tools with limited functionality are already in use at a few airports. More advanced tools supported by enhanced FDP system inter-operability will be available by 2005, and will be deployed at some of the major airports. The use of data communications links with aircraft and improved navigation information will further improve arrival management performance, and provide the platform for automated sequencing procedures by 2008. Parallel improvements in information management, and in the integration of ATC, airports and aircraft operators' planning processes, will allow greater flexibility in sequencing decisions, and in ATC responses to the changing operational needs of the aircraft operators.

7.3.9. Integrated Arrival and Departure Management

Separate departure management tools (DMAN) will be available by 2005 at most major airports. Both AMAN and DMAN will need to be evaluated independently, but integrated AMAN and DMAN systems should be widely available at the busier airports before 2008, and will provide the basis for further gains in airport air-side capacity by fully optimising the use of runways and local airspace. Further integration of these systems with those used for airport surface management starting in about 2008 and, with en-route ATM, ATFM and the aircraft operators' processes, will facilitate the transition to a full gate-to-gate management of flights by 2015.

7.3.10. Enhanced Safety Nets

The availability of more dynamic and accurate surveillance data, and improvements in Radar Data Processing Systems (RDPS), will provide enhanced safety net capabilities in the more advanced ATC units by 2000, and these should be available in all units by 2010. Specific functions include:

- Short-Term Conflict Alert - to warn of imminent and potential violations of safety parameters;
- Minimum Safe Altitude Warning - to help prevent controlled flight into terrain;
- Area Penetration Warning - to warn of impending and un-intentional incursions into airspace that a flight is not cleared to enter.

These ground-systems enhancements will be accompanied by the mandatory carriage of Airborne Collision Avoidance System (ACAS) II starting in 2000. The further evolution of safety nets is under discussion, but the principle of keeping safety nets functions distinct from the normal separation process will be maintained.

7.4. Airport ATC

Changes to airport ATC will derive from programmes that provide a change in the management perspective, the general adoption of 'best in class' standard operating procedures and the application of new technologies.

Gate-to-Gate emphasises the need to consider the airport as an ATC provider and requires improved integration of airport-airline-ATC operating data and management processes.

The identification, and ECAC-wide acceptance, of best-in-class procedures is only the first step in an effective programme that will culminate in their standard application. The appropriate procedures, consistently employed, will be significant in both their contribution to an increased capacity and a reduction of the environmental impact of air transport. Evidence from a number of airports has illustrated that harmonisation requires a pro-active stance by the airport working with the aircraft operator and pilot community.

New technologies, combined with improved tools to assist the controller, will be the third leg of the programme.

7.4.1. Gate-To-Gate at Airports

Improved planning procedures and early and continuous dialogue between the airport operators and airport ATC, en-route ATC and ATFM stemming from enhanced information management and more integrated systems will help to ensure that resources at capacity constrained airports are used more efficiently. Longer-term planning processes will seek to detect potential imbalances between forecast aircraft operator schedules and airport air-side capacity. Timely and shared information on real-time events will enable a more responsive management of the instantaneous demand and enable controllers to optimally adjust the traffic flows to meet the changing balance of arrivals and departures. Together with improved surface management, the integration of data and collaborative decision-making will facilitate improved gate and ramp management, and have a positive impact on flight punctuality and inter-connections, particularly at hub airports.

7.4.2. Harmonised ECAC Procedures

To integrate runway management with that of the en-route sectors, runway operations will have to be more predictable. Today the runway occupancy of departing and arriving flights has a variability that is an order of magnitude greater than that which will be achieved with 4D traffic control systems. A programme to establish universal adoption of piloting best-practice, as set out in the recommended High Intensity Runway Operations (HIRO) procedures, will be an important initiative. Research in conjunction with the European Commission and the ICAO Airport Operations Group and Visual Aids Panel will review options for improving pilot awareness on the runway.

7.4.3. Technology Gains

The integration of A-SMGCS with combined arrivals and departures management systems, the use of RNAV techniques, the gradual introduction of the future ICAO precision landing aids using satellite navigation information, optimised traffic routes around airports, and more collaborative schedule planning between adjacent airports, will provide the foundation for progressive improvement in all-weather operations by 2010. Arrival and departure rates in poor visibility conditions will be improved, and air-side capacity will begin to match that for operations in good visibility conditions.

7.4.4. Improved Runway and Surface Movement Management

Requirements for A-SMGCS are being defined by Industry, ICAO and EUROCAE (Minimum Aviation Specification Performance - MASPs), and some national administrations are already developing prototype systems that will satisfy part of the A-SMGCS needs. A key aspect will be to provide scaled and modular solutions that meet local traffic requirements.

Improved runway sequencing tools will enable controllers to gain extra air-side capacity at congested airports.

Changes in surface movement management, such as improved taxi patterns and fast exit lanes from runways, are already underway and will be introduced progressively. Tools to assist in integrating all airport surface movements will be available by 2002. Systems and tools to improve airport surveillance and traffic monitoring and enhance situational awareness in all-weather conditions should start to be deployed at the busier airports between 2004 and 2006, and their capabilities will be further expanded by the introduction of surface conflict detection and alert and guidance systems by 2010.

7.4.5. Wake Vortex

One of the factors that limits arrival and departure rates is the need to apply separation between aircraft to take account of the hazards associated with wake turbulence. In many cases, the separation required to avoid wake turbulence hazards is much greater than that which would be applied for purely runway occupancy or ATC separation considerations. Work associated with the improved detection of wake vortex, and in gaining a better understanding of its effects, is already taking place, and should lead to the application of reduced vortex separation minima in certain defined conditions. Initial changes are likely to be introduced by around the year 2002, and will be supported progressively by the availability of monitoring tools, which should be widely available by 2010. The use of tools to assist the task of controllers and pilots should make it possible to achieve capacity benefits by ensuring wake vortex avoidance without excessive controller workload.

7.5. System-Wide information Management

This section provides complementary information on AIS and MET aspects only.

7.5.1. Aeronautical Information Services

Aeronautical Information Services (AIS) ensure the flow of information needed for the safety, regularity and efficiency of international civil aviation. Each Contracting State is required to provide an aeronautical information service and to publish aeronautical charts. States are responsible for the information provided. The information must be timely, provided in a suitable form and of high quality.

7.5.1.1. AIS in CNS/ATM

The role and importance of aeronautical information/data has changed significantly with the implementation of area navigation, required navigation performance (RNP) and airborne computer-based navigation systems that are data-dependent. Aeronautical data have, therefore, become crucial and critical to the network.

AIS and mapping (MAP) services are essential components of ATM. Quality aeronautical information is required for the precise navigation necessary for guidance for gate-to-gate operations. These include the ability of aircraft to navigate on the ground and en-route using on-board navigation systems that can calculate the precise position and the optimum tracks and trajectories based on the latest information.

To support and facilitate the transition to the new global CNS/ATM system, aeronautical information and charting systems including 4D displays, will be further developed and oriented more towards global requirements as well as regional and national needs. A comprehensive reference database of quality assured aeronautical information for the ECAC area will be developed. These developments will contribute to improved safety, increased efficiency and will provide more cost-effective services to users. New specifications for electronic aeronautical data including terrain and vertical obstruction information will be developed.

Specifications for AIS and MAP digital information will need to be developed to take advantage of emerging communication facilities such as datalink.

7.5.1.2. AIS in Collaborative Decision-Making and System-Wide Information Management

The development of Collaborative Decision-Making tools necessary to support the future global ATM network will require access to global aeronautical information of the required quality. The aim, within the framework of system wide information management, will be to move to a system that provides on-line quality aeronautical information to users in real-time. To achieve this, aeronautical information must be provided in electronic form based on a commonly agreed and standardised data model. Strict quality principles will be put in place to ensure that aeronautical data is available, verified and validated.

An AIS strategy will be developed and implemented which will identify general principles, functions and future actions to provide a harmonised and integrated common strategic framework for AIS for the entire ECAC area. The development of the strategy will be co-ordinated with appropriate international and national agencies to help facilitate the creation of a seamless and transparent global AIS.

7.5.2. Meteorological Services

All phases of flight can be significantly affected by meteorological conditions. Safety, regularity and efficiency of air traffic will increasingly depend upon the timely, accurate, complete and up-to-date availability of Meteorology (MET) information to pilots, controllers, and planners.

Through co-operative links between ATS and MET service providers, ECAC needs will be integrated to provide the information that is necessary and sufficient for aviation purposes:

- wind information for flight planning;
- severe weather (thunderstorms, icing, turbulence);
- volcanic ash;
- low visibility and low cloud;
- wind shear, turbulence and wake vortex;
- airport conditions, snow, ice, etc.;
- distribution, integration and display of information.

Improved accuracy and timeliness will facilitate flight trajectory prediction resulting in greater precision in ATM networks and collaborative decision-making. This will improve efficiency of ATM and aircraft operations. Adverse weather conditions can be identified and managed more efficiently, thereby improving safety and flexibility, for example by routing aircraft around bad weather and providing more timely information on the need for diversion.

The management of aeronautical MET within ECAC will be progressively improved by co-ordination, under the EUROCONTROL Organisation, of activities such as :

- the assessment of current capabilities, developments and best practice;
- the assessment of emerging capabilities and the changes necessary and sufficient to meet future operational needs;
- the on-board aircraft meteorological data gathering for real-time MET data;
- the provision of appropriate MET facilities at airports including data processing and communications;
- minimisation of environmental impact of aircraft;
- en-route capacity optimisation during adverse weather;
- the assessment of costs, network-wide benefits and cost-recovery;
- the co-operative formulation of global standards with ICAO and World MET Organisation;
- the implementation of performance management and feedback to Meteorological Offices.

The activities will lead to programmes of work associated with ATM including, inter alia, the extent to which MET improvements act as an enabler to :

- time based separation on final approach;
- greater ATFM accuracy;
- trajectory prediction and conflict resolution;
- airport air-side capacity optimisation during adverse weather;
- use of RNAV in TMAs;

- reductions in weather-induced accidents.

In due course, the Strategy will address the benefits of:

- air-to-ground observations to improve overall forecast performance;
- ground-to-air forecast updates (nowcasting);
- air-to-air significant weather reports.

7.6. Human Resources

7.6.1. Humans and Change

Most of the changes outlined in the Strategy document are technologically or procedurally driven, but changes for humans working in ATM in the period covered by the Strategy will be equally dramatic and far-reaching. Humans have the power to effect and exploit changes, but they can just as easily frustrate progress if they perceive a threat to stability and safety. The commitment and co-operation of ATM staff will be crucial if the improvements in safety, capacity and efficiency are to be realised.

Human resources activities integrate human factors principles, which are fundamental to the quality of ATM services, with staff planning and employment, by which the service is delivered. Together, these elements interact to create a safe, efficient, flexible and harmonised use of human resources that, together with evolving technology, is an essential factor in increasing traffic handling capacity, and thus ATM capacity.

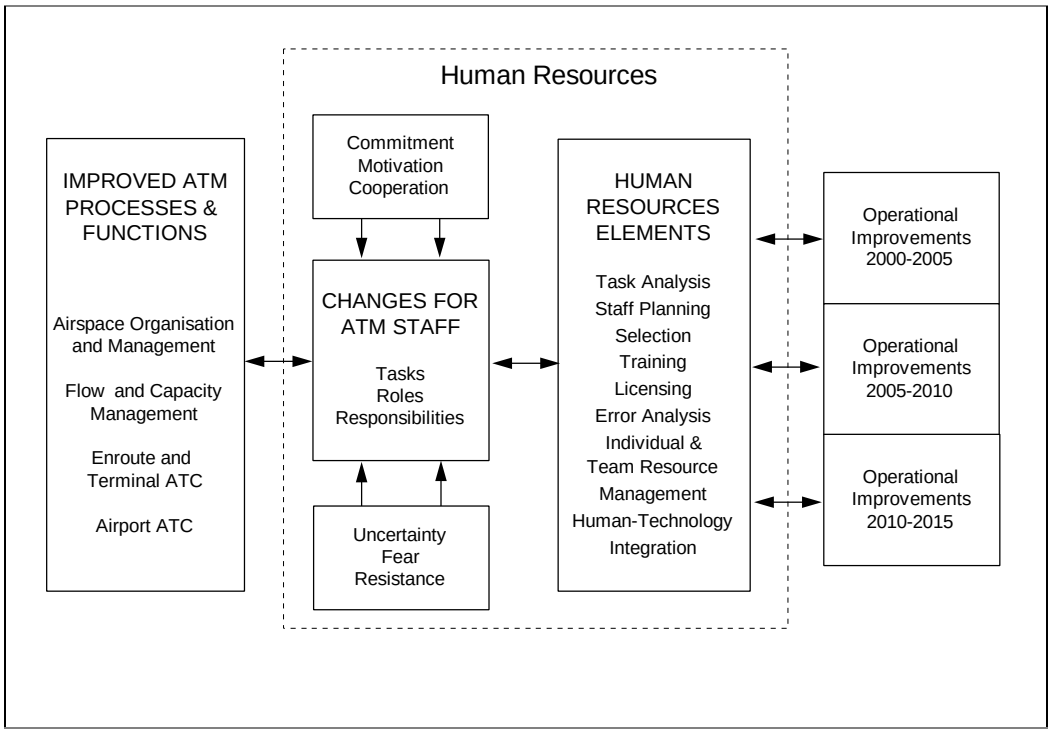

Figure 7 : The Role of Human Resources

The major assets of humans - besides their abilities, skills and knowledge - are creativity, flexibility, motivation and commitment to the job. Social and motivational factors of people must be taken into account to harness the potential of staff to work in harmony with technology and procedures. Appropriate computer support will help in stimulating ATM

staff to make better use of human cognitive abilities, which will adapt naturally to meet the new challenges presented by network capacity demands.

Manpower planning is aiming to be sufficiently robust to cope with the uncertainties of an increasingly complex network. In theory, manpower planning for ATM is well understood. Resources into the pool are a matter of recruitment and available budget; staff development is achieved by training and re-deployment; and staff losses are more or less predictable from demographic modelling. However, experience has shown that uncontrollable variables cause fluctuations that are difficult to manage, thereby upsetting the equation underlying the planning process. Appropriate human resources in both quantity and ability continue to be a major enabler to bringing about change.

7.6.2. Improved Use of Human Resources

A major challenge for European ATM is accurate estimation of the numbers and profiles of staff needed to operate the evolving network to its full potential. This also involves consideration of sufficient staff numbers to allow for training while still operating and maintaining the present ATM networks. Adequate means of measuring current human resources and future requirements are essential, and the resulting information will enable a better understanding of potential imbalances that, in turn, will suggest remedial solutions to manning problems. Provision of manpower planning data and methods will facilitate flexible strategic and tactical staffing within the various ATC sectors and units in line with operational requirements and capacity imperatives. To be effective, management of people must take full account of all aspects, including social and motivational factors.

Recruitment, selection, training and licensing procedures will enable the provision of a balanced and consistent stream of high quality ATM staff. Training and staff development must receive the attention and resources it deserves and be fully aligned with the needs of the service providers. Recurrent task analyses of ATM tasks will support the process of integration.

Commonly developed training programmes, which meet the needs of managers, planners and operators, will exploit pedagogical and psychological principles and newly available tools. Continuous and relevant training will be at the heart of the human resources strategy. It will recognise that fear of, and resistance to, change can be significantly reduced if staff are properly involved and pre-prepared.

The strong links between manpower planning aspects, such as selection and training, and human factors have been indicated earlier. Increasingly, the application of human factors principles will extend to all areas in the human resources field.

7.6.3. Improved Human Use of Technology

Human factors principles and methods have to be built in right from the start to increase the human commitment. The challenge is to balance carefully human and technical aspects by first asking what is operationally safe, useful and useable, rather than what is technically possible. The efficient use by humans of technology will be driven by a thorough R&D of cognitive and behavioural aspects in ATC. In all developments, the guiding principle must be enhancing human capabilities and motivation, and exploiting their flexibility.

Integration of human factors expertise and principles needs to be extended from analysis of existing or prototype systems towards proactive incorporation during system design and development. Involvement of ATM staff in human-machine system requirements definition, design and implementation is essential for the acceptance of new technology.

Continuation training will be only successful if new ideas and improvements are part of the staff attitudes and beliefs about safe and efficient operations.

New systems will help to avoid current forms of ATM related errors but at the same time will introduce new forms of errors. Error analyses and different types of continuation training will help to foresee and prepare for potential forms of error more acutely, and deal with them effectively. This in turn will reduce possible human performance 'costs' of automation, such as loss of operational awareness, over-reliance, mistrust and skill degradation which needs to be integral part of any cost-benefit consideration and analysis.

Additionally, Human Factors education programmes together with guidelines, and assessment and evaluation tools for developers, will encourage the design of increasingly error tolerant or even fault resistant systems, thereby enhancing aviation safety. Human Factors education programmes and training for enhanced Individual and Team Resource Management, and appropriate management training will help ATM staff and management to implement new tasks, roles and responsibilities.

7.6.4. The Way Forward

By concentrating its efforts within identified essential projects, the Human Resources domain will pave the way for the changes. Firstly, it will acknowledge and publicise the necessary and expected contribution from humans. Through a series of guidance documents it will prepare managers, planners and ATM staff for the impact of technological and other enabling enhancements, pointing out the problems that have to be overcome. It will contribute human factors expertise to system development at all levels and to all technical domains, and seek to exploit the potential strengths of operators. The domain will develop programmes and models for the run up to each change implementation, and design transition plans to capture the extra demands on ATM staff, both in quantity and abilities. In total, the Human Resources programme will be necessarily ambitious in order to secure the full co-operation and support of the operational work-force. Without them, the Strategy cannot meet its targets.

7.7. Technical Integration

Enablers can be defined as elements being necessary to achieve required operational improvements of ATM systems. They can be split up into two categories, technical and other enablers.

A large proportion of the technical enablers are elements defined and produced under the aegis of CNS. Examples are RNAV equipment and datalinks. Other enablers are of a more general nature. They can be agreements on adaptations of working arrangements between ATC Units or, as another example, the training of Operational/Technical Staff for new ATC procedures and/or the introduction of new technologies.

For the latter category of enablers it is not possible to define some general rules. For the technical enablers, however, a number of starting points/prerequisites can be applied. They will be treated in more detail in the CNS section hereafter, as CNS is the main driver for technical enablers.

Furthermore, two enablers are specifically highlighted in this chapter, as there is a need for swift actions on those subjects.

7.7.1. CNS

The role of the CNS infrastructures is to support/enable the operation of ATM. ATM improvements can often only be realised when supported by improvements to one or more of the CNS components.

CNS developments are not only driven by ATM needs, but also by the general evolution of technology. This enables the implementation of more cost-efficient infrastructures. Moreover, it may provide opportunities for ATM evolution at the same time.

Interaction between ATM and CNS strategy developments and plans is needed to ensure that ATM-required CNS support is available and ATM has the opportunity to benefit from increased CNS functionality and/or performance enablers through technical evolution.

CNS infrastructures need to be compliant with operational and general requirements. Operational requirements are directly derived from the supported ATM function and include safety requirements. These requirements have an impact on the design and development of the CNS components and their test methods.

General requirements apply to the entire infrastructure and are related to economical principles and the environment in which the CNS components are used.

Important non-operational requirements include:

- the applied technology for CNS needs to be mature;
- whenever technically and economically feasible, new technology or CNS components should built on or integrate with existing CNS infrastructure;
- upgraded or new CNS infrastructures need to be scaleable at least in terms of performance and geographical coverage;
- CNS infrastructures, when involving airborne components, need to be globally inter-operable.

Development and implementation strategies have been defined for the CNS domains in which system and service enhancements are laid down as a function of time. The strategies develop from a number of specific requirements, such as technical practicability, operational need, dependencies on other domains, etc. They provide the direction for the development and deployment of the necessary enablers.

The link between enablers and improvements for aircraft and airport-operators and Air Navigation Service Organisations has been defined. A step still to be carried out is the definition of the interdependencies between the CNS projects.

7.7.2. CNS Strategies

7.7.2.1. Communications Strategy

The primary goal of the Communications Strategy is to develop safe, efficient and cost-effective communications solutions that support the evolution of the European ATM network and air navigation services for the ECAC area, and which is both compatible with global communications developments and can be reached from existing systems. It also recognises the need for co-ordination with the relevant bodies (EU, ICAO, FAA, JAA etc.). Services will be provided by making use of the most appropriate and relevant technologies, and provide low cost solutions for general aviation and aerial work.

In particular, the strategy addresses the timely provision of:

- data communications services, to provide end-to-end connectivity (application to application) and broadcast capabilities for air-ground, air-air, and ground-ground application purposes;
- voice communications services to provide the end-to-end and broadcast voice capabilities for air-ground, air-air and ground-ground purposes.

through the following supporting network services:

- the Pan-European Fixed Network Services (PENS), providing the international ground telecommunications infrastructure by the interconnection of national infrastructures for voice and data, including network systems management, end-to-end voice and data integrity, switching and routing, multiplexing and message handling;
- the Mobile Network Services (MNS), providing the communications links between mobiles (aircraft or vehicles) and between mobiles and ground elements, for voice and data over wireless links (radio, satellite and other), including network systems management.

7.7.2.2. Navigation Strategy

The main objective of the Navigation Strategy is to identify a cost-effective, customer oriented, evolutionary transition of the European Air Navigation Systems towards a uniform European ATM network, and to provide a harmonised and collaborative ECAC framework to achieve this transition. The strategy describes available and potential air navigation applications and means of supporting these applications, in terms of required performance, functionality, and enabling infrastructure. It recognises the users' requirements as the main driver in its development, against a background of the ICAO Global Air Navigation Plan for CNS/ATM systems.

The main strategic streams for the Navigation domain are aimed at:

- achievement of a total RNAV environment with defined RNP values in designated airspace for all operations ECAC-wide;
- facilitating the implementation of the 'free routes' concept;
- supporting the continued operation of General Air Traffic of non-compliant State aircraft;
- the implementation of 4D RNAV operations, to support the transition to a full gate-to-gate management of flight by 2015;
- judicious deployment and use of supporting ground- and space-based infrastructure for all phases of flight, ensuring the transition to Global Navigation Satellite Systems (GNSS) in the long term, in line with ICAO recommendations;
- supporting the continued operations of aircraft with lower capabilities as long as operationally feasible and in full awareness of the impact of changes on this population.

Advances in navigation functionality will be implemented to enable improvements in airspace design (structure, sectorisation, associated route network, applicable route spacing, separation minima and responsibilities, etc.), and allow for a high degree of flexibility for aircraft operations and for the navigational equipment used. Ultimately, all these elements, together with appropriate ATM tools, will enable operators to conduct their flights in accordance with their preferred trajectories, dynamically adjusted, in an optimum and cost-efficient manner.

The Navigation Strategy recognises the emergence of satellite technology and its future role in the global navigation environment. However, it is expected (based on current knowledge) that the rate of technological development of the system, and the time needed

for the resolution of institutional limitations, will result in the need for a ground-based back-up system for GNSS for the foreseeable future for all phases of flight. Therefore, the total number of ground Navaids is expected to be reduced to that necessary to provide that back-up.

7.7.2.3. Surveillance Strategy

The Surveillance Strategy describes the evolution of the surveillance infrastructure through the exploitation of the benefits of new technologies as they become available. The strategy is based on the use of various technological surveillance solutions allied to the anticipated context and performance requirements for particular geographical areas. It addresses the full scope of the gate-to-gate concept, and takes into consideration low cost solutions for general aviation and aerial work.

The strategy puts into perspective current (primary, Monopulse Secondary Surveillance Radar (MSSR), Mode S) and emerging (Automatic Dependent Surveillance (ADS), ADS-Broadcast (ADS-B), etc.) technologies and their expected performance, and distinguishes between:

- airspace where MSSR will exceed its capabilities and be replaced by Mode S. Once fully developed and validated for operational use, ADS-B could be used to complement SSR Mode S;
- airspace where MSSR will not exceed its capability. In such airspace MSSR systems will be replaced by ADS at the end of their operational life where their retention would constrain capacity. It may be possible to retain some MSSR systems in low density airspace for the entire period covered by the strategy;
- airspace where radar infrastructure does not exist or is not practicable where ADS-B will be used to provide positional information. However, there would be no independent means of validating the accuracy of the data presented to the controller and no back up if ADS-B failed;
- airport surface movement surveillance, where ADS-B and multilateration are currently considered as technologies (subject to validation) that are capable of supporting advanced surface movement guidance and control systems.

Until ADS-B can be supported by a “sole means” of GNSS derived position, it must continue to be supported by a ground based surveillance function in those areas where specific levels of services need to be maintained.

7.7.3. Frequency Spectrum Management and Protection

One of the most important conditions for an improvement of ATM capacity and safety is the efficient exchange of data between all stakeholders. This need is increasing rapidly and includes data communications between ground units and between aircraft and ground units. For much of this data transmission, radio frequencies are essential. However, increasing competition for the use of frequencies, mainly from non-aviation interests, is jeopardising the desired aim for safety and capacity improvements. A political initiative is needed to ensure that sufficient of the frequency spectrum is allocated for aviation needs.

Additionally, a better general management of the allocated frequencies is needed, and technological developments which contribute to the more efficient use of frequencies must be stimulated and supported.

7.7.4. Need for Cost Effective Ground Communication Infrastructure

Another important element of modern ATM systems is an efficient ground communication infrastructure. It must be recognised that there is an urgent need for the realisation of a new infrastructure, otherwise the development of improvements will be at risk. This is particularly true for collaborative decision-making, information sharing and information management where there is a requirement for extensive real-time data exchange.

8. The Steps for Improving Performance

8.1. The Steps

This section contains the transition steps to achieve the Operational Improvements.

Two general remarks have to be made on the contents.

It must be clear that the foreseen activities and developments for the short-term are more mature than those for the medium and long-term. This means that only at a later stage can a more realistic planning of achievements be given for medium- and long-term improvements.

It also has to be understood that the percentage figures given for the anticipated performance improvement for each step are based on the assumption that the targets associated with the objectives set out in the EATCHIP ATM R&D Strategy [8] will be met. The figures are preliminary estimates, based on expert judgement, and are being reviewed on the basis of more analytical work. Nevertheless, they attempt to accommodate the fact that individual capacity gains provided by the different improvements cannot simply be added, since they might not provide gains in all parts of the airspace or in all traffic situations. They should also not preclude other gains being sought from the application of 'best practices'.

8.2. Step 1 (up to 2005)

The first period - the shorter term - will focus on the following strategic actions:

- improving capacity as a priority and enhancing efficiency wherever possible by concentrating on changes to airspace organisation, current procedures and human resources management, and by providing increasing support to the controller, with emphasis on the executive controller in this period;
- preparing existing systems for further integration to meet the traffic increases, and introducing new basic features into flight data processing systems;
- general use of best current practice.

It will include the full deployment of a number of harmonisation and integration measures which have already been developed and planned in the present Convergence and Implementation Programme (CIP). These will improve performance and provide the following operational improvements:

SAFETY:

- enhanced safety nets and tools.

CAPACITY:

- enhancement of ground based planning during all phases of flight, including better pre-flight planning, improved departure management, linear holding and improved arrival management;
- route structure and sector optimisation based on RNAV techniques and the introduction of RVSM;

[8] **EATCHIP** Yellow Book Issue 3.2

- progressive improvement to surface movements control and air-side capacity management at major airports.

EFFICIENCY AND FLEXIBILITY:

- initial implementation of free-routing airspace and operations in the upper airspace;
- improved flexibility in the use of airspace;
- improved re-routing;
- optimisation of rostering, staff assignment, management arrangements and working conditions;
- improvements to individual and team working practices.

Associated enabling changes to the ground infrastructure will comprise:

ATM SYSTEMS:

- FDPS upgrades to support advanced data processing and flexible route operations;
- progressive deployment of arrivals management tools at major airports;
- improved surface management systems and procedures at major airports;
- upgraded human-machine interfaces and controller work positions;
- implementation of the Enhanced Tactical Flow Management System (ETFMS);
- initial introduction of system-wide information management techniques.

COMMUNICATIONS:

- introduction of ATN data communications infrastructure;
- introduction of mobile data communications at major airports to support departure clearances and ATIS;
- upgrading of the ground communication environment to create a more cost-effective infrastructure;
- introduction of 8.33 kHz spacing to create more RT channels.

NAVIGATION:

- introduction of RVSM;
- initial exploitation of satellite navigation.

SURVEILLANCE:

- introduction of Mode S enhanced surveillance in core area.

Associated changes to the management of human resources will comprise:

- development and introduction of methods and tools to analyse current and future tasks and the roles and responsibilities of operational staff;
- provision of strategic and tactical manpower planning data and tools to provide and maintain a sufficient number of qualified personnel;

- introduction of co-ordinated recruitment, selection, training and licensing procedures to provide a high ability profile of operational and technical staff;
- provision of resources and upgraded training for new human-machine interfaces and controller work positions;
- introduction of individual and team resource management practices to ensure the provision of safe, efficient and flexible operations;
- development and introduction of awareness and training programmes for transitions and changes in tasks, roles and responsibilities of operational staff.

The accompanying avionics requirements, not necessarily for all users and all airspace, will be:

- Basic Area Navigation (B-RNAV) (RNP 5);
- RVSM MASPs (for all a/c wishing to fly above FL280);
- Mode S transponder (level 2 minimum);
- 8.33 kHz voice channel spacing (for all a/c wishing to fly in 8.33 airspace);
- ACAS II;
- Multi-Mode Receiver (MMR) (optional);
- VHF Datalink (VDL), other mobile subnetwork(s);
- Aeronautical Telecommunications Network (ATN) (optional);
- ACARS (optional).

The combination of these changes is aimed at providing an estimated increase in capacity of up to 60% by 2005 when compared to 1995 levels, and a reduction in fuel burn per flight in the order of 3%, which will benefit both flight efficiency and environmental objectives. Also, there should be 15 to 30% reduction in ground movement emissions.

This first step involves complex changes (new AOCs and FDP systems) in some areas, and still relies on classical control-sector organisations. Nevertheless, it should help to at least stabilise average unit costs. Safety levels will also benefit from the extended use of safety nets and the introduction of ACAS II.

8.3. Step 2 (2005 to 2010)

The period from 2005 to 2010 will see an acceleration of the integration of ATM information into other related information systems (AOC's, Airports, etc.) and the optimisation of the use of airspace and airport resources. Improved integration of the aircraft operator and ATM processes based around enhanced information systems and information management, together with increasing use of data communications links, will facilitate collaborative decision-making. The availability of more accurate trajectory and surveillance information passed in real-time, and the introduction of advanced computer support tools will provide better trajectory prediction and conflict avoidance planning. Suitably capable aircraft will be able to exercise autonomous separation under prescribed circumstances or in certain airspace areas. Airspace management and organisation will become more flexible and dynamic.

The main operational changes will improve performance as follows:

SAFETY:

- further deployment of safety nets and safety improvements.

CAPACITY:

- enhanced conflict prediction and trajectory planning with air-ground collaboration supported by data link communications;
- integrated arrival and departure management;
- enhanced ATFM procedures and initial capacity management;
- improved airport surface movement ground control and planning.

EFFICIENCY AND FLEXIBILITY:

- enhanced airspace flexibility and sectorisation changes;
- collaborative civil-military airspace planning for all airspace;
- extended free-routing airspace and operations;
- limited transfer of separation responsibilities from the ground to the air;
- continuing improvement in rostering, staff assignment, management arrangements and working conditions;
- extended improvements in individual, team and organisational working practices;
- collaborative flight planning procedures.

Associated changes to the ground infrastructure will comprise:

ATM SYSTEMS:

- Flight Data Processing System (FDPS) / Collision Warning System (CWS) replacements for free route sectors and FDPS upgrades for other sectors.

COMMUNICATIONS:

- ATN data communications at some major airports and High complexity Area Control Centres (ACCs);
- extension of mobile sub-networks in the communication infrastructure.

NAVIGATION:

- growing use of GNSS;
- progressive rationalisation of ground navigation infrastructure.

SURVEILLANCE:

- introduction of enhanced ground surveillance systems at major airports;
- introduction of ADS-Contract (ADS-C)and ADS-Broadcast (ADS-B)

Associated changes to the management of human resources will comprise:

- recurrent analyses of current and new tasks, roles and responsibilities of operational staff;
- upgrading of strategic and tactical manpower planning data and tools;

- the provision of strategic and tactical manpower planning data and tools to provide and maintain a sufficient number of qualified personnel;
- upgrading of tools for recruitment, selection, training and licensing;
- continuation of awareness and training programmes for transitions and changes in tasks, roles and responsibilities;
- comprehensive upgrading of training for new human-machine interfaces and controller work positions.

The avionics requirements, not necessarily for all users and all airspace, will be:

- ATN;
- mobile subnetwork(s);
- enhanced Flight-Management System (FMS) capabilities and new HMI;
- RNAV RNP1 or better (optional);
- ASAS avionics (optional);
- ADS-C (optional);
- ADS-B (optional);
- ground surveillance support system capabilities.

The above changes are aimed at providing potential capacity increases in the region of 20 to 40% in addition to those in Step 1, and a further fuel burn reduction of around 2 to 3 %. Target levels of safety will also be enhanced. It may be possible to utilise some of the capacity increase to reduce the number of ATM units. Further benefits should accrue from the modernisation of the ground infrastructure and the decommissioning of a number of older systems.

8.4. Step 3 (2010 to 2015 and beyond)

The third period will be marked by full adoption of the target concept. The main thrust will be:

- the re-distribution of tasks between the human and the machine and, where applicable, between the air and the ground, to improve levels of productivity;
- implementation of co-operative ATM through integrated air/ground data communications and surveillance, including airborne situational awareness, in a number of ACCs/UACs, major airports and TMAs, supported by a significant number of suitably equipped aircraft;
- optimisation of procedures, processes and assistance tool algorithms based on the availability of more accurate data and other technical improvements.

Specific advances will relate to the increasing use of computer support tools, both on the ground and in the air, more integrated systems and planning, and continuing improvements in information management. Flights will be managed gate-to-gate and airspace will be regarded as a continuum for planning and management purposes, with few restrictions. The majority of flights will be able to fly fuel-efficient routes, and it will be possible to apply autonomous separation in the appropriate airspace areas.

The main operational improvements will be:

SAFETY:

- Continued improvement of safety.

CAPACITY:

- enhanced all-weather air-side capacity operations at all major airports;
- extensive use of computer tools for sequencing and separation;
- optimised capacity management.

EFFICIENCY AND FLEXIBILITY:

- collaborative planning involving all European airspace;
- gate-to-gate planning and conduct of flights;
- introduction of autonomous aircraft operations.

Ground system changes will comprise:

ATM SYSTEMS:

- optimised 4D ATM tools;
- the implementation of multi-sector planning.

COMMUNICATIONS:

- fully integrated common ground and mobile ATN based data communication infrastructure;
- ATN applications enabling 4D ATM.

NAVIGATION:

- RNP1 RNAV MASPs or better;
- further rationalisation of ground navigation infrastructure.

SURVEILLANCE:

- transition to new surveillance infrastructure depending on local requirements.

Associated changes to the management of human resources will comprise:

- introduction of fully integrated human resource management tools into the system development process to investigate and overcome restrictions on overall systems objectives;
- recurrent analyses of current and new tasks, roles and responsibilities of operational staff;
- comprehensive training programmes for transitions and changes in tasks, roles and responsibilities;
- comprehensive upgrade and continuation training for new procedures, human-machine interfaces and operators work positions.

The avionics requirements, not necessarily for all users and all airspace, will be:

- 4D trajectory exchange/negotiation capability;

- ASAS.

These changes are aimed at providing the potential for additional capacity gains in the region of 20 to 40% in addition to those in Step 2, and the foundations for further capacity increases in line with traffic growth beyond 2015. ATM penalties should be reduced to their minimum level, and the principles of 'intervention by exception' will become the norm. The limitations on any future improvements will then be environmental factors and runway saturation.

A more detailed view of the links between the objectives, operational improvements and enablers is given in Appendix 2, and a view of the impact that the operational changes will have on the roles and responsibilities of the air and ground elements over time is given in Appendix 3.

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9. Management

9.1. General

This chapter complements the equivalent chapter in Volume 1, and provides additional guidance material and descriptions of proposed or on-going actions concerning the managerial issues. It must therefore be read in conjunction with the Volume 1 material to obtain a comprehensive view.

9.2. Rule-Making

9.2.1. Rule-Making Aims

Rules are a mechanism to build transparency, trust, confidence and consensus on change among all major stakeholders (National Authorities, service providers, airspace users and manufacturing industry) and can be achieved, among other measures, by a new European Notice of Proposed Rule-Making (ENPRM) process for ATM.

9.2.2. Legal Framework and Instruments

The revised EUROCONTROL Convention will provide the legal framework for the practical management arrangements. Within this framework, rules and standards will be produced which may be transposed by further legal instruments into regulations which are applied in each of the Member States. The content of rules or standards will range from general objective setting, which will allow the concerned parties to determine freely how they wish to react to those objectives, to detailed provisions where such details will be essential to the success of a project.

9.2.3. The Rule-making Process

Nine steps have been identified for any successful rule-making activity. Within an ATM context, these are:

- identification of the Strategic Direction and associated decisions by the EUROCONTROL Council and General assembly;
- identification of the work programme to meet the strategic direction;
- identification of options and establishing consensus around proposed solutions;
- identification of costs and benefits;
- publication of first draft text;
- consultation process with stakeholders;
- revision of text following comment and evaluation;
- approval of rule by the EUROCONTROL Council and General Assembly;
- publication of rule and configuration control where appropriate.

The above steps are followed by implementation and enforcement where appropriate. A new rule-making process will constitute the final result of relevant work undertaken by the European aviation community and will result in agreement about the course of action to be

pursued. It necessitates a definite commitment on the part of Member States, their ATM service providers and airspace users to implement the changes as stipulated in the rule.

This process will be initiated and co-ordinated under the auspices of the EUROCONTROL Council and General Assembly by the EUROCONTROL Agency, in close co-operation with Members States, Services Providers, Airspace Users, Manufacturing Industry, ICAO, EC, JAA/EASA, EUROCAE and other aviation rule-making/drafting bodies.

The JAA has established a rule-making process. In view of the trend of increasing integration of ground and airborne systems, there is a need to ensure compatibility of the principles used and the consistency of the parallel actions to be taken on subjects of common interest.

9.2.3.1. Scope of Rule-Making

It is considered essential that the content of European rule-making is compatible with all relevant ICAO requirements. The initial priority for rule-making is perceived to be associated with service provision and particularly with the implementation of common projects which require a uniform and synchronised application if planned ATM benefits are to be realised.

Under the terms of the revised Convention, rules may be created for adoption by the EUROCONTROL Organisation in the following areas:

- safety;
- performance;
- inter-operability;
- the use of scarce resources.

9.2.3.2. Level of Uniformity to be Achieved

Uniformity embodies the application of common ATM rules and core functions across all European airspace. This calls for inter-operable systems and agreed common rules, standards and practices which will establish acceptable tolerances for performance, and safety levels to cater for operational circumstances which may arise throughout the European air and ground traffic management system. It is expected that narrow tolerances will be applied to the core functions. For less sensitive environments, wider tolerances are appropriate and will allow for flexibility at a regional level so as to reflect local traffic demand and operating conditions.

9.2.3.3. Standards and Specifications

A uniform European ATM network requires a number of standards, the implementation of which brings demonstrable benefits to the aviation community. The global importance of ICAO SARPs is recognised in all States and will remain as definitive statements of operational practice in the Strategy. European rules, standards and practices will be developed as a complementary programme so that a foundation for uniform performance across European airspace can be established and implemented.

Standardisation should:

- limit the scope of mandatory standards strictly to the performance and inter-operability/interface requirements;
- ensure that Industry is able, from the early stages, to participate in the development of standards, helping to achieve realistic and cost-efficient specifications traceable to agreed ATM requirements;

- rely as much as possible on available commercial standards.

In addition to the normal standardisation process, emphasis is also placed on the de facto or voluntary standardisation processes. To help achieve this objective, a greater priority will be placed on the validation of new functions and products, followed by the wide dissemination of the results. Additionally, the EUROCONTROL Organisation should, where necessary, develop proper processes for declaring that products/systems are compliant with a standard. The scope of these proposals will be further defined. ATM requirements will be defined in such a manner as to allow Industry to develop the detailed specification whilst ensuring full traceability of the design to the high-level requirements.

9.2.3.4. Signifying Compliance with Rules by Certification and Qualification

Mechanisms are required which, in all cases, signify compliance with adopted and promulgated rules in a way which is demonstrable, visible and offers the appropriate assurance of compliance to interested parties.

In the case of safety rules, the process of certification has been successfully used in other aviation sectors for many years to meet this need. To an appropriate extent, it is intended to apply a similar concept to the safety areas of ATM service provision, principally by using the recommendations of the EUROCONTROL Safety Regulation Commission. The division of responsibilities and the scope of certification in the ATM environment will be the subject of further study.

However, there is a significant range of ATM rules which have objectives other than safety, such as harmonisation, technical performance, or inter-operability through standards defined by the EUROCONTROL Organisation. In each case, a directly parallel process, to be termed *qualification*, will be established to meet the need to demonstrate compliance with rules in these areas.

9.2.3.5. Notification of Rules

The need for a clear notification system during the rule-making process has been identified by airspace users and is reflected in the proposed new rule-making process.

There is a need to maintain an authoritative record of all rules under configuration control. The harmonised publication of information relating to common implementation activity will assist with the realisation of project objectives.

An authoritative record of all rules subject to configuration control is required, and harmonised publication of information related to common implementation activities will assist in realising programme objectives.

Proposals for a single means of communications with stakeholders will be developed by the EUROCONTROL Agency for the consideration of the Council and General Assembly.

The development and publication of an official journal to assist in the regulatory process and in determining National transposition measures should be investigated.

9.2.3.6. Rule-making and the Regulatory Process

Regulation may be described as the adoption, enactment, and implementation of rules for the achievement of stated objectives by those party to the regulatory process. Regulation may be applied to Economic, Safety and key Performance objectives.

Regulatory and rule-making activities will be proportional to the objective to be realised and be consistent with safe, expeditious and economic operations. Where different rule-

making bodies are involved there is a need to ensure compatibility of the principles used and the consistency of the parallel actions to be taken on subjects of common interest.

Figure 8 shows the relationship between policy drafting, rule drafting/rule setting and implementation in a chronological way and with reference to the EUROCONTROL Organisation environment. The key points to note are:

- all rules derive from agreed ATM policy decisions;
- rule-making consists of a drafting and a setting stage;
- the implementation of rules is a distinct part of the regulatory process.

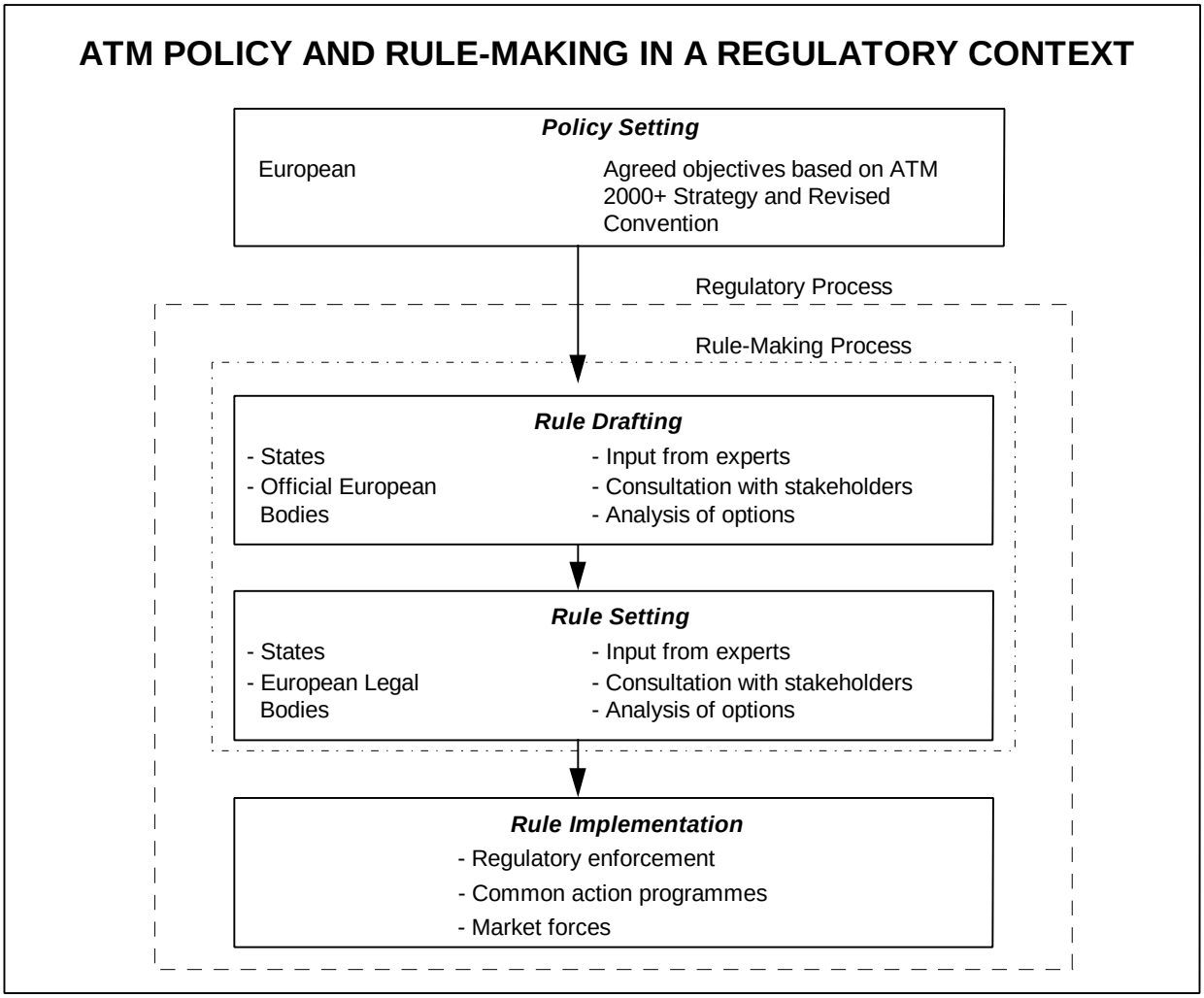

Figure 8 : Policy and Rule-Making

The application of rules by the contracting parties, and the way to obtain the most effective method, will be the subject of further study. The following options have been identified:

- Member States enacting rules within their national legislation;
- the "Direct Effect" clause, where a rule defined on the basis of an international convention directly takes binding legal effect in the participating States without the need for transforming it into national legislation;
- an addition to the revised Convention.

9.2.3.7. Initialisation of Rule-Making

The revised Convention has identified the main initiators of rule-making activities as:

- the States and their Service Providers;
- the Director General of EUROCONTROL;
- the Safety Regulation Commission;
- the Performance Review Commission.

Any rules proposed by the above parties will be submitted for adoption by the General Assembly and the Council. There may be merit in considering a "Rule-making and Standards Board" to oversee the whole process and validate all rule-making requirements. If ATM stakeholders share this proposal, then more study is required to develop the scope, position and authority of such a Board.

9.3. Involvement of Industry

To help ensure more realistic and cost-efficient specifications, Industry should be involved as early as possible in the life-cycle of a project.

The EUROCONTROL Organisation will manage the processes that involve the definition and validation of new solutions, and make the maximum use of Industry's capabilities, ensuring the early involvement on that part of Industry that is potentially in a position to deliver the commercial product.

The EUROCONTROL Organisation's role will be to guide the market by defining agreed high level requirements/specifications, and helping to initiate and/or ensure the availability of suitable products.

In relation to Industry involvement in R&D activities, increased emphasis will be placed on disseminating relevant information on R&D projects and results. The EUROCONTROL Organisation must organise regular meetings with suppliers.

Bearing in mind the importance of reinforcing the links between Industry and research establishments to reduce the gap between research and industrial development, the Agency, in conjunction with Industry and service supplier organisations, will aim to create a functional platform (an Industry Based Prototype) where systems from several suppliers, covering ground and air segments, could be interconnected to represent a complete operational environment, and ease functional validation. Expected benefits include increased standardisation and inter-operability, as well as reduction of development risks.

The Agency should analyse the need to introduce a formal quality check for agreed system components to ensure that a particular product is globally compliant with a given set of requirements. This would lead to a EUROCONTROL "label" delivered by the EUROCONTROL Organisation. It is expected that implementing those proposals could deliver significant benefits to both the customers and their suppliers.

With the objective of encouraging competitive industrial offers that meet the requirements, the following two measures should be applied Concerning Intellectual Property Rights (IPRs):

- for R&D activities, where the challenge is to transfer knowledge to Industry while maintaining a high level of competition, to adopt a case-by-case approach to put the appropriate results of the R&D activities in the public domain;

- for common procurements, to rely as much as possible on double development, which should safeguard the existence of double sourcing and the maintenance of competition and to leave the IPRs with the suppliers.

In addition to the normal standardisation process, emphasis should be placed on de facto or voluntary standardisation processes. To achieve this, the EUROCONTROL Organisation must give high priority to the validation of new functions and products, and disseminate the appropriate results widely. It should also develop processes for promulgating the compliance of products and systems with a particular standard.

9.4. Contingency Planning

To ensure safety and a continuous operation, the European ATM network must be able to deal with different contingencies at all levels of operation.

The objective of contingency planning is to prepare for uninterrupted operations at all times regardless of technical or catastrophic failures, as well as industrial action, be it a breakdown of a radio frequency at a small airport or a major international crisis. This will be achieved by developing contingency plans at all levels and co-ordinating the plans.

9.5. Research and Development

The validation of future procedures and technologies against quantified system performance objectives (operational, technical and economic) must be completed in due time using R&D. The Strategy relies strongly on the progressive implementation of innovations rather than the continuation of traditional solutions. Measures have to be taken to secure appropriate support from R&D, with priority given to areas which support quick solutions, but without neglecting the basic R&D needed to prepare for the longer-term evolutionary steps.

Growing pressure for cost-effectiveness will be applied to all aspects of expenditure including R&D. However, simply reducing R&D costs might result in losing potential high value creativity. A better co-ordination of efforts to achieve greater efficiency on a European scale should therefore be achieved.

ATM R&D must meet the essential needs of the Strategy, ensuring that successful R&D products move quickly into development and implementation by reducing the time necessary to implement results and start receiving the expected benefits. To this end, pre-operational field trials should be encouraged at local, national and international level. These should take account of the European-wide visibility of the tested component rather than focus on its restricted local application. R&D must estimate benefits by identifying the benefit mechanisms, and validate and quantify the effects of the tested improvement during pre-operational field trials.

The planning and execution of ATM R&D must be co-ordinated in order to maximise the value of its output. Collaborative programmes which lead to more efficient use of resources and a more effective exchange of ideas must be fostered to cover the need for improved exchange of research information. Synergy between all ATM R&D actors including Industry and users will be developed. Involvement of users in the R&D planning process is essential.

In recent years, performance of expensive avionics equipment has outstripped that of ground ATM systems, and priority will be given to improving ATM performance without imposing additional mandatory carriage requirements which do not provide clear benefits for the users.

The regular review of ATM R&D initiated recently to provide high level advice to those responsible for execution of the R&D programmes in support of the Strategy will be maintained and strengthened. The overall European ATM R&D Strategy addressing R&D priorities, which translates the R&D needs associated with the ATM components into specific strategic actions, will be maintained.

The EUROCONTROL Agency may use the leverage effect of its R&D budget to provide incentives to projects compliant with the Strategy. In this way, it can play a major role in ensuring that R&D is delivering the right products to the ATM programmes at the right time. The Agency's efforts must be supplemented by support from the European Commission's programmes, taking into consideration the accession of the European Community to EUROCONTROL, so that these efforts take account of the interaction of ATM with other activities and more general policy issues.

The aim will be that the ATM R&D needs of common interest be described and prioritised centrally, and then addressed through a collection of several programmes financed by the EUROCONTROL Agency's, National and other budgets, and complemented by local actions for national issues. A more concentrated sponsorship will deliver cost reduction through economies of scale. The proportion of ATM R&D activities carried out or funded by a single stakeholder is expected to decrease as European integration progresses and the use of common solutions increases. Enhanced co-operation, funding rules and competition mechanisms must be implemented as appropriate both during tendering and execution phases.

The main required actions related to R&D build on the relevant section of the ECAC Institutional Strategy and are:

- implementing more effective ATM R&D co-ordination mechanisms across various European and National Organisations to support ATM developments;
- collecting data on projects to determine the most efficient use of resources;
- maintaining R&D expertise in a distributed European framework;
- concentrating R&D resources on the development and validation needs of the uniform European ATM network;
- Ensuring that R&D reflects the latest scientific knowledge and technology developments regarding aviation and the environment.

9.6. Economics

9.6.1. Cost-Benefit Analysis in General

The infrastructure changes needed to support new concepts and procedures require investment from both the airspace users and ATM service providers. It is essential that the level of benefit received by the organisations making the investment is commensurate with the investment required. Since the costs and benefits of the Strategy will be experienced by all aviation parties, cost-benefit studies will have to evaluate the effects of the changes on the whole of the air transport network.

One potential difficulty for this approach is that the organisation making the investment may not benefit directly from the ensuing improvements. The Strategy aims at making sure that, where possible, each organisation receives a fair return on the investment required to fund the changes via operational benefits.

Cost-benefit assessments will need to consider the effects of the proposed changes at an overall level, and for the typical main groups of interests, to ensure that the changes

proposed are both viable and affordable. However, it is inevitable that in some instances the changes will involve more drawbacks than advantages for some minority groups.

9.6.2. Demonstrating the Economic Case

It is essential that the economic case for activities needed to realise the Strategy be demonstrated. The following two elements are the basis of the case and key to achieving this:

- an estimate of the value of the extra capacity that the Strategy expects to deliver;
- the total costs of delivering the capacity.

A comprehensive set of cost estimates has to be established. The planning and high level costing of programmes within strategies must be the responsibility of the authorities responsible with the help of cost-benefit analysis experts.

Much of the information needed may be derived within the EUROCONTROL Organisation, but some information must be provided by the States.

As part of the management of the Strategy, the economic case should be monitored constantly to assure all stakeholders that value is delivered.

9.6.3. Economic Studies

A number of Economics objectives have been set out in Section 4.3. However, the shortage of knowledge of the economic impact of the changes in ATM makes the identification of agreed lines of action on Economics difficult at this time. Political issues will have to be addressed before some of the options can be considered.

A proposal for possible studies is set out in Appendix 4, which will in itself generate further questions and proposals to look at other options. The responsibility for much of this will fall on the EUROCONTROL Organisation. It is important that the Organisation ensures that the required resources are made available for this work in the early days of the Strategy to underpin its implementation.

10. References

1. ECAC Institutional Strategy for Air Traffic Management in Europe; dated 14 February 1997
2. Report on the fifth meeting of ECAC Ministers of Transport on the air traffic system in Europe (MATSE/5); dated 25 February 1997
3. ECAC Strategy for the 1990s - Relieving Congestion In & Around Airports, dated 17 March 1992.
4. ECAC En-route Strategy for the 1990s, dated 24 April 1990
5. Report of the Fourth meeting of the special Committee for the monitoring and co-ordination of development and transition planning for the Future Air Navigation System (FANS); dated March 1995
6. EATMS Mission, Objectives and Strategy Document (MOSD); Issue 1.3; dated 6 July 1995
7. EATMS User Requirements Document (URD); Edition 1.0; dated 6 September 1995
8. Operational Concept Document for the EATCHIP Phase III Systems Generation; Edition 1.1; dated 28 June 1995
9. EATMS Operational Concept Document (OCD); Issue 1.1; dated August 1998
10. IATA Concept for Air Traffic Management in the Future Air Navigation System; dated March 1995
11. Future European Air Traffic System (FEATS); ICAO EUR Doc 004
12. ICAO Implementation Strategy of the Future Air Traffic Management System in the European Region; dated June 1990
13. Air Traffic Statistics and Forecast, EUROCONTROL Document 98 to 14
14. IFATCA Vision Document; IFATCA 1997

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11. Acronyms and Abbreviations

4D	Four Dimensional
ACC	Area Control Centre
ACARS	Aircraft Communications Addressing and Reporting System
ACAS	Airborne Collision Avoidance System
ADS	Automatic Dependent Surveillance - Broadcast
ADS-B	Automatic Dependent Surveillance - Broadcast - Broadcast
ADS-C	Automatic Dependent Surveillance - Contract
AEA	Association of European Airlines
AIS	Aeronautical Information Services
AO	Arrivals Operations
AOC	Airline Operations Centre
AMAN	Arrival Manager
ANS	Air Navigation Services
APATSI	Airport/Air Traffic System Interface
APO	Airport Operator
ARDEP	Analysis of Research and Development in Europe
A-SMGCS	Advanced Surface Movement Guidance and Control System
ASAS	Airborne Separation Assurance System
ASM	Airspace Management
ATC	Air Traffic Control
ATFM	Air Traffic Flow Management
ATIS	Air Traffic Information Service
ATM	Air Traffic Management
ATN	Aeronautical Telecommunications Network
ATS	Air Traffic Services
B-RNAV	Basic - Area Navigation
CADS	Computer Aided Departure System
CDM	Collaborative Decision-Making
CEAC	Committee for European Airspace Co-ordination
CFIT	Controlled Flight into Terrain
CFMU	Central Flow Management Unit
CIP	Convergence and Implementation Programme
CMIC	Civil-Military Interface Committee
CNS	Communications, Navigation and Surveillance
COTS	Commercial Off the Shelf (system)
CODA	Central Office of Delay Analysis
CRCO	Central Routes Charges Office
CWS	Collision Warning System
DMAN	Departure Manager
EA	Europe Airsports
EAD	European AIS Database
EATCHIP	European Air Traffic Control Harmonisation and Integration Programme
EC	European Commission
ECAC	European Civil Aviation Conference
ECARDA	European Coherent Approach of Research and Development in Air Traffic Management
ENPRM	European Notice of Proposed Rule-Making
ERA	European Regions Airline Association
ESA	European Space Agency
ETFMS	Enhanced Tactical Flow Management System
EUROCONTROL	European Organisation for the Safety of Air Navigation
FAA	Federal Aviation Administration
FANS	Future Air Navigation System
FEATS	Future European Air Traffic System
FUA	Flexible Use of Airspace(Concept)
FDP	Flight Data Processing (system)
FIR	Flight Information Region
FMP	Flow Management Position
FMS	Flight Management System
FOC	Full Operational Capability
GDP	Gross Domestic Product
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HDD	Head Down Display

HIPS	Highly Interactive Problem Solver
HMI	Human Machine Interface
HIRO	High Intensity Runway Operations
HUD	Head Up Display
IACA	International Air Carrier Association
IAOPA	International Council of Aircraft Owner and Pilot Associations
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IOC	Initial Operational Capability
IFATCA	International Federation of Air Traffic Controllers Associations
IPR	Intellectual Property Rights
ISO	International Organisation for Standardisation
ITT	Invitation to Tender
JAA	Joint Aviation Authorities
MATSE	ECAC Transport Ministers' meeting on the Air Traffic System in Europe
MAP	Mapping
MASP	Minimum Aviation Specification Performance
MET	Meteorology
MMR	Multi-Mode Receiver
MSAW	Minimum Safe Altitude Warning
MSSR	Monopulse Secondary Surveillance Radar
MTCD	Medium Term Conflict Detection
NAV	Navigation
NAT	North Atlantic
NATO	North Atlantic Treaty Organisation
OCD	Operation Concept Document
PENS	Pan-European Fixed Network Services
PRC	Performance Review Commission
PRU	Performance Review Unit
R&D	Research and Development
RDPS	Radar Data Processing System
RNAV	Area Navigation
RNP	Required Navigational Performance
RT	Radiotelephony
RVSM	Reduced Vertical Separation Minima
SARPs	Standards and Recommended Practices
SMAN	Surface Management System
SMGCS	Surface Movement Guidance and Control System
SRC	Safety Regulation Commission
SRU	Safety Regulation Unit
SSR	Secondary Surveillance Radar
STCA	Short-Term Conflict Alert
TACT	CFMU Tactical Computer System
TMA	Terminal Control Area
UAC	Upper Area Control Centre
URD	User Requirements Document
VDL	VHF Datalink
VHF	Very High Frequency
WMO	World Meteorological Organisation

Appendix 1 : Strategic Actions By Phase Of Flight

This table shows the objectives, the strategic actions needed to support those objectives, and the potential costs and benefits of those actions, by phase of flight. The time windows given are approximate and intended to represent progressive implementation. To avoid over-complicating the tables, the costs in column 5 are not directly aligned on the page with the corresponding strategic actions in column 3; however, indications of the type of strategic actions, and/or systems, to which they refer are included in brackets where possible.

Phase of Flight	Objective	Strategic Actions	Date	Attribution of Costs	Benefits
Strategic Planning	• adapt capacity to demand while accommodating cost-benefit considerations	• adaptation of ATC and airports capacity within acceptable safety and environmental limits including airspace planning; • provision of demand data to relevant partners (CFMU and airports); • provision of route options and financial information to airspace users; • provision of the appropriate human and technical resources; • early interaction between service providers, CRCO, airports and airspace users; standardisation of National AIPs; • efficient HMI and tools to access AIS information.	• on-going 2000 to 2015 • 2000-2010 • 2000-2005 • on-going 2000 to 2015 • 2000-2010 • 2000-2005	• airspace users and service providers (procedural changes); • airports (for additional slot scheduling computer facilities); • some investment needed to standardise AIS information and increase communication;	• enablers which provide benefits in other phases of flight.
Pre-tactical planning	• ensure that strategically planned capacity is available to meet needs and provide flexibility to cater for additional or modified airspace user needs.	• provision of adequate human and technical resources to meet the demand on the day of operation; • co-operation between AOs, ATC, ATFM and airport authorities to provide flexibility in managing airport capacity; • efficient access to AIS information.	• on-going 2000 to 2015 • by 2010 • by 2005	• airport operators for AIS, MET and ATFM interface systems; • airspace users and service providers for interface systems.	• enablers which provide benefits in other phases of flight.
Tactical planning	• provide aircraft operators with information that enables them to plan flights for optimum profile / trajectory / route.	• integration of information on capacity constraints at ATCCs and airports to provide optimum airport scheduling information; • integration of ATC and ATFM information together with decision-making tools to provide optimum flight profiles; • enhanced FDP capabilities for ATM and airport ATC to accommodate late flight plan changes; • alignment of tactical Airspace Management (ASM) and Air Traffic Flow Management (ATFM) with ATC to provide capacity where needed; • airspace user access to integrated flight information (AIS, MET, ASM, etc.); measures to prevent system abuse (multiple flight plan filing, etc.).	• 2000-2005 • 2000-2010 • 2000-2010 • 2000-2005 • 2000-2005	• service providers and CFMU for enhanced dynamic flight plan processing capabilities; • service providers and airports for enhanced data processing to provide flexibility in handling flight plan changes.	• greater flexibility; • optimised airport capacity; • enhanced services to the airspace users.
Pre-departure	• provide timely data to allow flight crews to prepare optimum flights.	• incorporation of ATFM, airports, AIS, Met, ATS, AOC and aircraft into an interactive and integrated system that provides complete and relevant real-time data; • user-friendly HMI and tools to access the integrated system; • automated co-ordination and decision-making tools to support optimum profile planning. (e.g.: arrival manager, departure manager, etc.).	• 2000-2010 • 2000-2010 • by 2010	• CFMU, service provider and airports for software/hardware to support integrated system.	• optimisation of airport resources (re use of missed slots); • improved flexibility; • reduced flight costs for operators; • minimal increase in ATC workload.

Phase of Flight	Objective	Strategic Actions	Date	Attribution of Costs	Benefits
Departure - Taxi	• maximise runway utilisation to ensure minimum taxi time and seamless transition between gate and take-off.	• integration of arrival, apron and departure managers; • integration of ATC, ATFM, airports and AOC information; • adequate airport surveillance (A-SMGCS, ASDE) where needed.	• 2000-2010 • by 2010 • by 2012	• airports and service providers for integrated information systems and • A-SMGCS; • airspace users for system interface requirements	• decrease in cockpit workload; • improved use of airport capacity • better runway utilisation.
Departure	• smooth and optimise the transition from take-off to en-route utilising the most efficient profile.	• optimised arrival and departure routes within an agreed environmental policy; • improved availability of real-time flight data from aircraft and AOCs • flight profile prediction and optimisation tools; • conflict resolution tools. • integrated arrival/departure managers at adjacent or close airports; • optimised airport instrumentation for local weather measurement.	• 2000-2005 • 2000-2010 • 2000-2010 • by 2008 • by 2008 • 2000-2005	• service providers for computer tools; • airport and service provider for adjacent/close airport information collation systems; • airports for weather and windshear detection systems.	• optimised flight profiles • increased arrival and departure rates.
En-Route	• make the en-route phase of flight a seamless phase of the overall gate-to-gate approach.	• revised institutional policies to facilitate gate-to-gate operations; • inter-related ASM, ATS and ATFM policies and integrated information systems; • compatibility of air and ground systems; • dynamic capacity adjustment; • multi-sector operations and planning tools; • trajectory monitoring tools; • autonomous separation activities in specified areas;	• on-going by 2015 • by 2010 • on-going by 2015 • by 2010 • 2000-2010 • by 2005 • by 2015	• service providers for revised/new procedures, etc.; • service providers for integrated information handling systems; • service providers for planning / monitoring tools • service providers for enhanced flight data processing capabilities; • airspace users for airborne separation systems.	• significant operational savings through synergy of en-route and other areas developments.
Arrival	• maximise runway utilisation and provide a smooth and seamless transition from the en-route to arrival phase using the most efficient profile; • to accommodate different landing priorities for a given operator to optimise hub and spoke operations.	• optimised arrival and departure routes within an agreed environmental policy; • improved availability of real-time flight data from aircraft; • flight profile prediction and optimisation tools; • conflict resolution tools; • integrated arrival/departure managers at adjacent or close airports; • metering and sequencing tools; • commonality of landing aids; • optimised airport instrumentation for local weather measurement.	• by 2005 • by 2010 • by 2005 • by 2008 • by 2008 • by 2008 • by 2010 • by 2008	• service providers for computer tools; • airport and service provider for adjacent/close airport information collation systems; • airports for weather and windshear detection systems; • airports for Cat I/II/III landing aids.	• optimised flight profiles; • increased arrival and departure rates.
Arrival - Taxi	• ensure minimum taxi-time and a smooth transition between the runway and gate.	• integration of arrival, apron and departure managers; • integration of ATC, ATFM, airports and AOC information; • adequate airport surveillance (SMGCS, ASDE) where needed.	• by 2015 • by 2012 • by 2012	• airports and service providers for integrated information systems; • airspace users for interface systems.	• optimised flight profiles; • increased arrival and departure rates.
Post Flight	• provide a single authoritative source of data on completed flights; • provide an efficient and consistent charging system at the lowest possible cost.	• single networked flight data base for archived flight plans, and modifications based on actual events; • integrated charging system.	• by 2005 • by 2008	• central bodies (CFMU/CRCO).	• cost saving in charge generation process.

Appendix 2 : Operational Improvements, Enablers and Benefits

The following tables show the link between the identified Operational Improvements and the key enablers[9], and also the links to the benefits that they bring in terms of capacity, efficiency and safety. The tables are based on best current information, and will need to amended over time to reflect changes which occur as the result of validation, cost-benefit analysis, etc., results.

The basic enabler is a reliable CNS/ATM infrastructure. Changes to this infrastructure are driven by operational requirements and by economical factors. The table only shows the required changes to the CNS/ATM infrastructure driven by operational requirements.

The enablers are presented according to the simplified segmentation discussed in Chapter 5 and enablers to be implemented in ground CNS/ATM systems, by aircraft operators (in the aircraft or by AOC), and by airport operators are identified where possible. Some operational improvements, especially those related to ATFM and collaborative planning require enabling ground systems. All of the operational improvements listed will need to be accompanied by new or revised procedures, which will have to developed and introduced in parallel with the operational improvements.

The timings given in the tables are approximate only, and refer generally to the start date for the introduction of the measure(s) described.

The Links with Benefits tables indicate the expected timescales and objectives (Capacity, Efficiency and Safety) - the grey shaded areas - to which the specific operational improvement described is expected to contribute the greatest benefits.

[9] The list of technical enablers is not exhaustive and will be influenced by cost-benefit related decisions made about technical choices, as well as by system architecture decisions.

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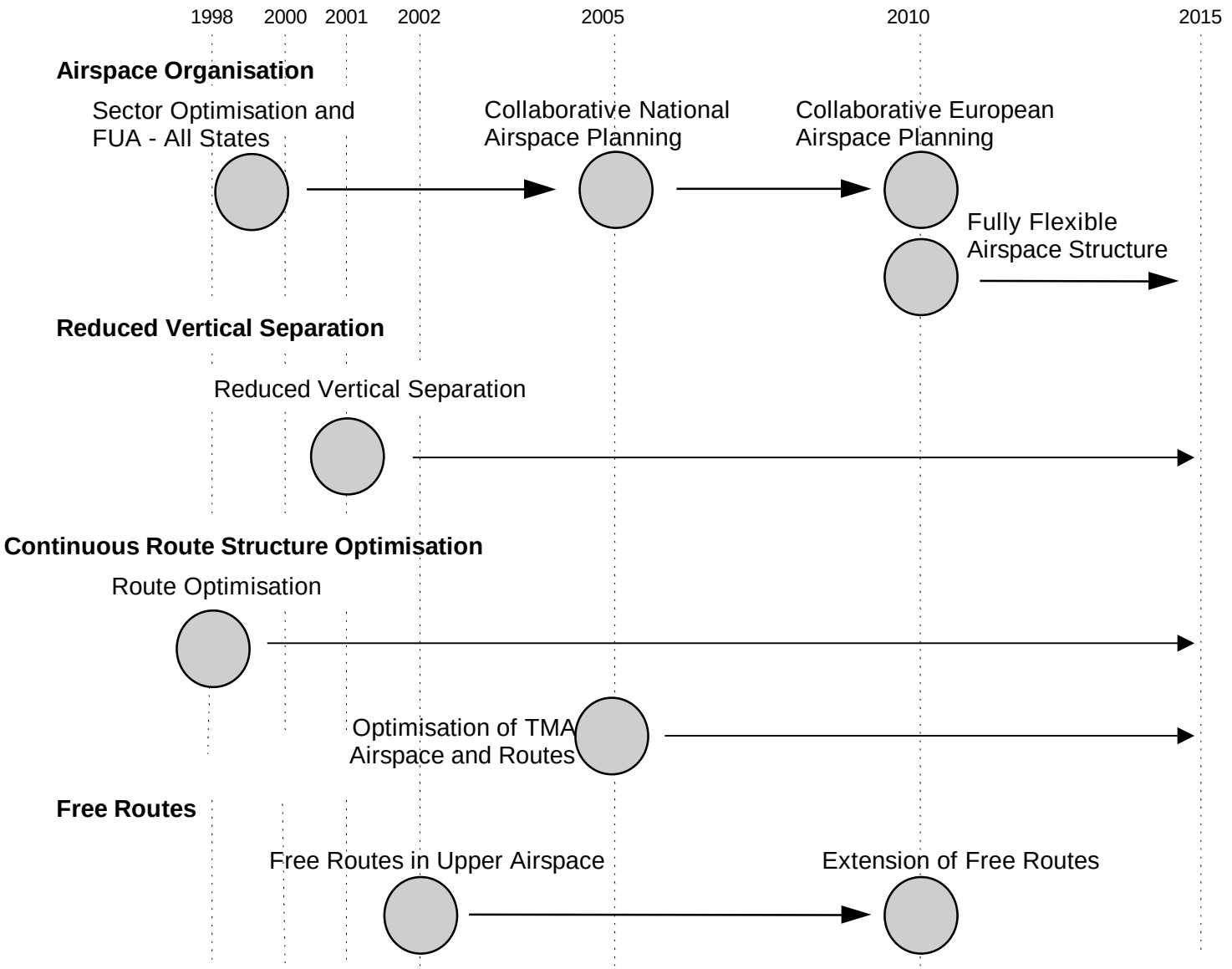
Operational Improvements - Airspace Organisation and Management



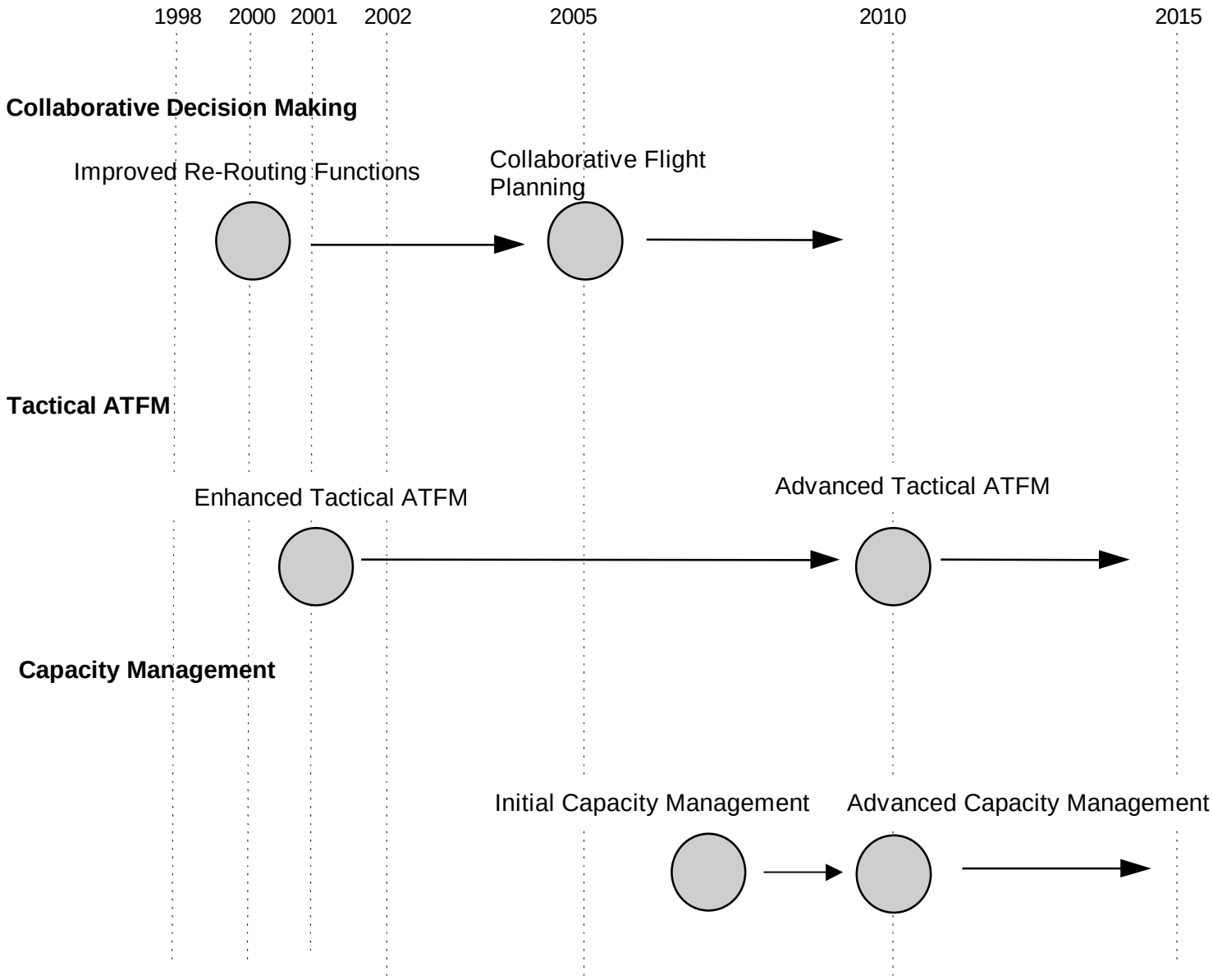
Airspace Organisation and Management

Improvements		Enablers					
Description	Date/ Area	Aircraft Operators		ATMO		Airport	Others
		AOC	Aircraft	ATM Systems	CNS		
Airspace Organisation							
Sector Optimisation and FUA	1998 - All States		- 8.33 Khz spacing	- Advanced airspace management co-ordination tools (shared real-time information) - Enhanced FDP systems - Dynamic environment data management	- Ground data communications infrastructure - 8.33 Khz spacing		
Collaborative (Civil-Military) National Airspace Planning	2005 - Most States			- Advanced airspace management co-ordination tools - Enhanced FDP systems - Dynamic environment data management			
Collaborative European Airspace Planning	2010 - Most States			- Advanced airspace management co-ordination tools - Enhanced FDP systems - Dynamic environmentdata management			
Fully Flexible Airspace Structure	2010 onwards			- Advanced airspace management co-ordination tools - Enhanced FDP systems - Dynamic environment data management			
Reduced Vertical Separation (RVSM)							
Reduced Vertical Separation	2001		- RVSM MASPs altimetry system - ACAS II	- MASPs indication in flight label			
Route Structure Optimisation							
Continuous Route Structure Optimisation	1998-2015		- RNAV equipment - RNP1 or better capability (optional before approx 2010)	- FUA tools - Enhanced FDP systems	- NAV infrastructure suitable for RNAV operations		
Optimisation of TMA Airspace and Arrival & Departure Routes	2005 onwards : Partial/Regional		- RNAV equipment - RNP1 or better capability (optional before approx 2010)	- Enhanced ATC tools	- NAV infrastructure suitable for RNAV operations		
Free Routes							
Free Routes in Upper Airspace	2002 : Limited number of States		- RNAV equipment	- Enhanced FDP systems and ATC tools - MET information			
Extension of Free Routes	2002-2010	-CDM	- Avionics enhancements - RNAV equipment - Air/Ground Datalink	- Collaborative flight planning - Enhanced FDP systems - Enhanced/new ATC tools (incl. Collision warning systems) - Dynamic environment data management - Dynamic MET information	- Air/Ground data communications infrastructure - NAV infrastructure suitable for RNAV operations		- EAD

Links with Benefits - Airspace Organisation and Management

Operational Improvement	Changes	Up to 2005			2005 to 2010			2010 to 2015		
		Capacity	Efficiency	Safety	Capacity	Efficiency	Safety	Capacity	Efficiency	Safety
Airspace Organisation										
	Sector Optimisation and FUA		✓							
	Collaborative National Airspace Planning		✓							
	Collaborative European Airspace Planning					✓				
	Fully Flexible Airspace Structure								✓	
Reduced Vertical Separation		✓								
Route Structure Optimisation										
	Continuous Route Structure. Optimisation.	✓			✓			✓		
	Optimisation of TMA airspace and Arrival and Departure Routes				✓			✓		
Free Routes										
	Free Routes in Upper Airspace		✓							
	Extension of Free Routes					✓				

Operational Improvements - Flow and Capacity Management



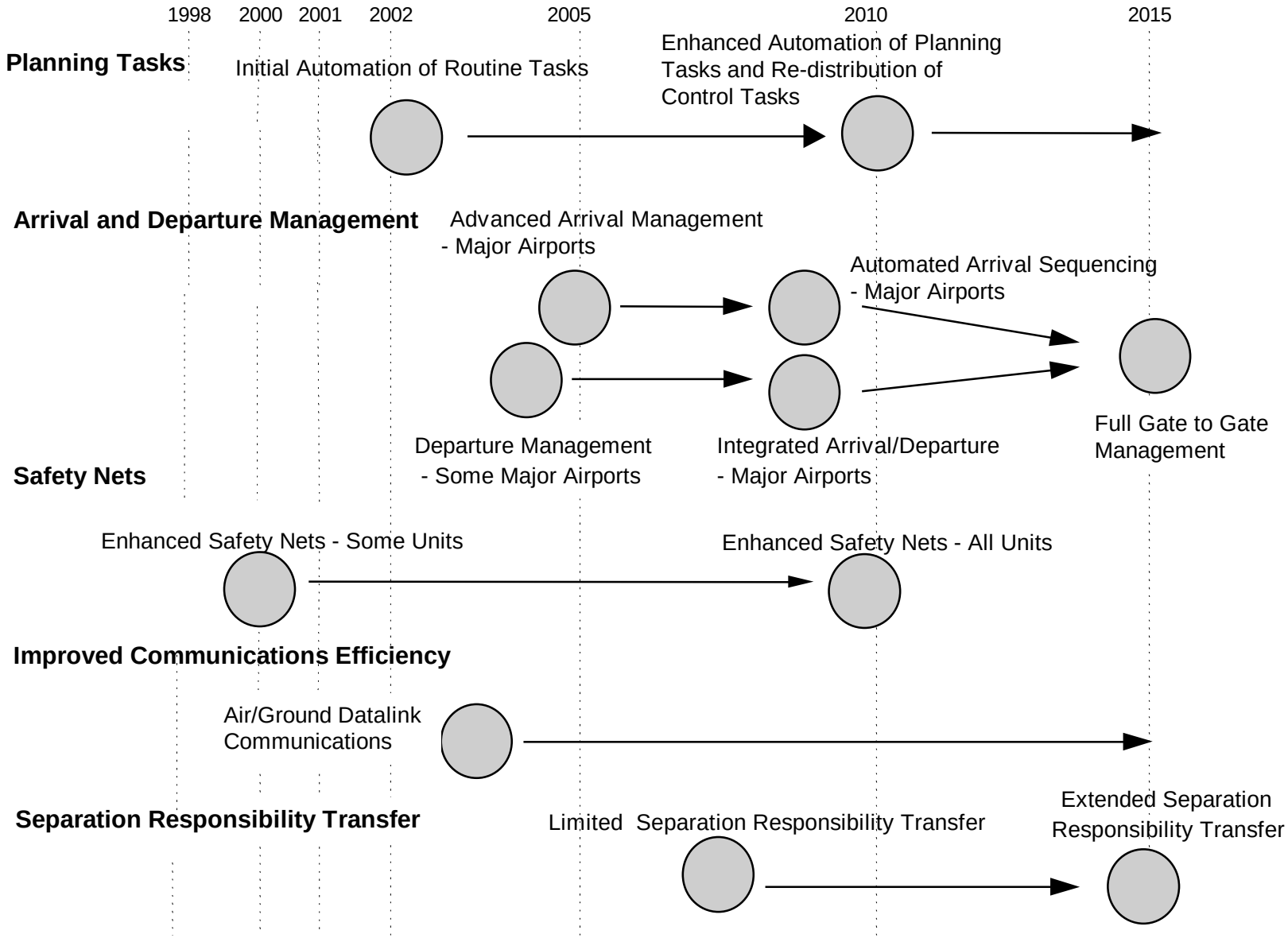
Flow and Capacity Management

Improvements		Enablers					
Description	Date/ Area	Aircraft Operators		ATMO		Airport	Others
		AOC	Aircraft	ATM Systems	CNS		
Collaborative Decision-Making							
Improved Re-routing Functions	2000			- IFPS & TACT software upgrades (improved profile, wide addressing) - ADEXP message exchange - Archive tools to monitor CFMU performance - Improved profile calculation in flexible environment	- Ground data and voice communications infrastructure		
Collaborative Flight Planning	2005		- Air/ Ground data link	- Integration of ATC, ASM & ATFM information - Integration of information on capacity constraints (Airports & ATC) - Efficient HMI/interface & tools to access integrated flight information (AIS, MET, ASM, etc): FMP Terminals and Flight Input Workstations (FIW) - Further IFPS & TACT developments - New/upgraded ATFM tools - Initial Enhanced Tactical Flow Management System (ETFMS) - Enhanced FDPS - Route Builder supporting tools - Recalculation of flight data for Flexible Use of Airspace (FUA) - Trajectory prediction with free route environment and FUA	- Extended interconnection of computer systems (AOC, Airports, ATM) - Data exchange with external areas - Air/Ground data communications infrastructure	- Exchange of information on capacity constraints (Airports & ATC)	- EAD - Electronic AIPs - Revised NOTAM format
Tactical ATFM							
Enhanced Tactical ATFM	2001 - 2005			- TACT developments (improved slot allocation algorithms, link CFMU/Airport exchange data) - Initial Enhanced Tactical Flow Management System (ETFMS) - Improved on-line access to CFMU operational data - FMP tools - TACT Contingency Plan - Processing of exceptional conditions	- Ground data communications infrastructure	- Exchange of relevant data between CFMU and Airports	
Advanced Tactical ATFM	2010 onwards			- Integration of Airports, ATC & ATFM information (arrival/departure/platform management optimisation) - TACT developments (demand/capacity optimisation) - Full Enhanced Tactical Flow Management System (ETFMS) - Development of CEU and FMP tools	- Extended interconnection of computer systems (AOC, Airports, ATM)	- Integration of Airports, ATC & ATFM information (arrival/departure/platform management optimisation)	
Capacity Management							
Initial Capacity Management	2008 onwards			- FUA tools - Improved pre-tactical tools (“What if” simulations) - Improved prediction data processing and tools - Enhanced Tactical Flow Management System (ETFMS) - Graphical capacity display			
Advanced Capacity Management	2010 onwards			- New/upgraded ATFM tools (incl. FMP) - Full Enhanced Tactical Flow Management System (ETFMS) - Full integration with TACT and -What If- tools			

Links with Benefits - Flow and Capacity Management

Operational Improvement	Changes	Up to 2005			2005 to 2010			2010 to 2015		
		Capacity	Efficiency	Safety	Capacity	Efficiency	Safety	Capacity	Efficiency	Safety
Collaborative Decision Making										
	Improved Re-routing Functions		✓							
	Collaborative Flight Planning					✓				
Tactical ATFM										
	Enhanced Tactical ATFM	✓			✓					
	Advanced Tactical ATFM							✓		
Capacity Management										
	Initial Capacity Management				✓					
	Advanced Capacity Management							✓		

Operational Improvements - En-Route and Terminal ATC



En-Route and Terminal Air Traffic Control

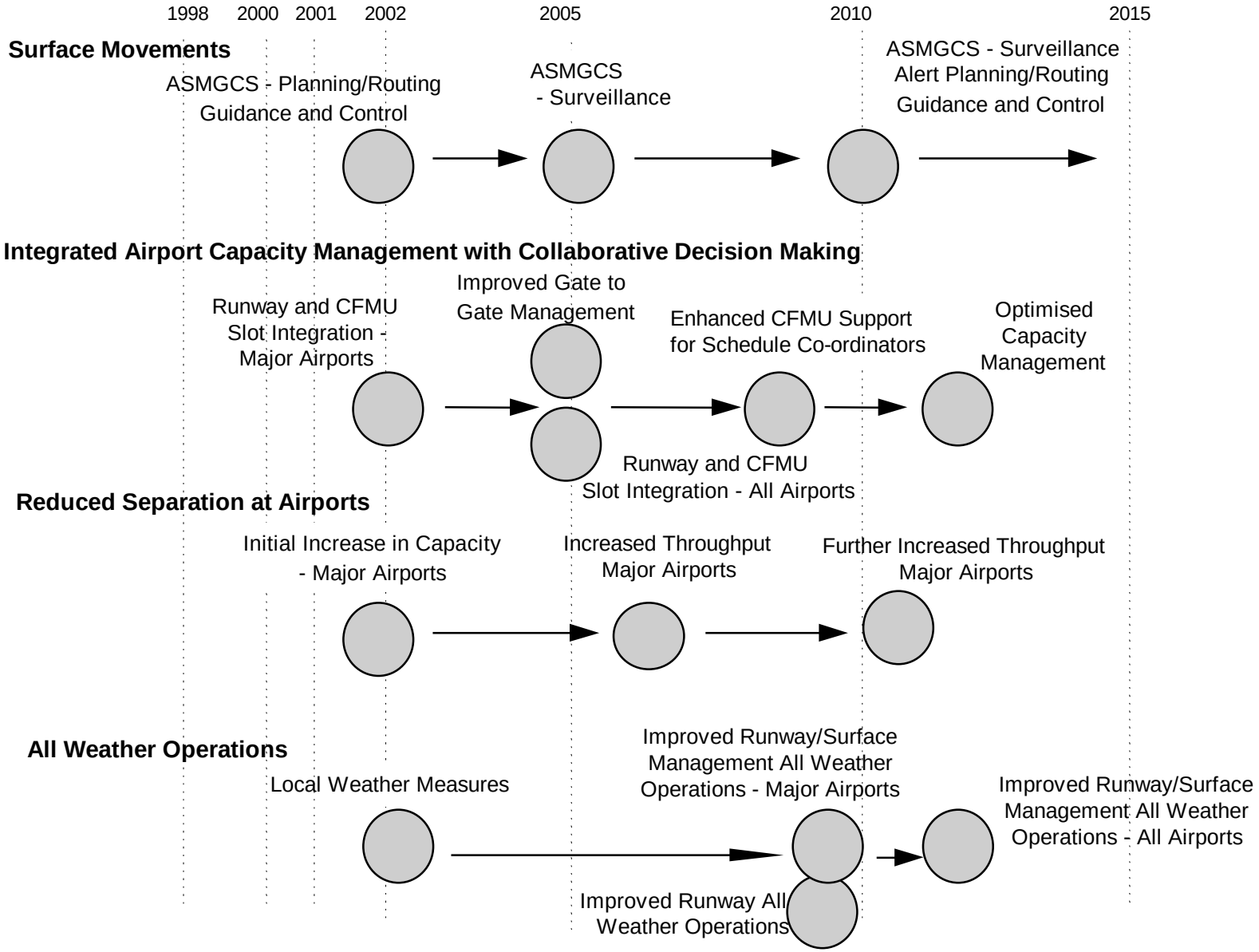
Improvements		Enablers					
Description	Date/ Area	Aircraft Operators		ATMO		Airport	Others
		AOC	Aircraft	ATM Systems	CNS		
Planning Tasks							
Initial Automation of Routine Tasks	By 2002 - At isolated ACCs 2005 - At high and medium ATC complexity ACCs		- Air/Ground Datalink - ADS (optional) - Enhanced Mode S	- MTCD and problem solving tools - Monitoring aids (MONA: conformance monitoring, automatic reminders) - Improved FDP functions (Trajectory Prediction) - Inter-operable FDPs - Adequate flight data for trajectory prediction - Common environment data (EAD + ASM) - Enhanced HMI (enhanced CWP)	- Available & accurate surveillance data (Mode S enhanced surveillance + enhanced tracking) - Air/Ground data communications infrastructure - Ground data communications infrastructure - CPDLC and ADS (for downlink a/c parameters)(optional)	- A-SMGCS	- MET data for improved TP - EAD - Digital terrain and vertical obstruction data - 3D + time graphical charting displays
Enhanced automation of routine planning tasks and redistribution of control tasks (including multi-sector planning)	2010 onwards - At high and medium ATC complexity ACCs		- 4D FMS - ADS - Air/Ground Datalink	- Integration of ground planning functions - Multi-sector operations & planning tools - 4D Trajectory monitoring tools - 4D FDP tools - Inter-operable FDPs - Dynamic & accurate environment data (EAD + ASM) - Enhanced HMI (enhanced CWP)	- ADS - Air/Ground data communications infrastructure	- A-SMGCS	- EAD - Digital AIS by gate link, satellite transmission, etc.
Arrival and Departure Management							
Advanced arrival management	2005 - at major airports			- More advanced arrival manager tools - Enhanced FDPS inter-operability	- Ground data communications infrastructure	- A-SMGCS - Arrival management tools	
Automated arrival sequencing	2008 - at major airports	CDM	- Air/Ground Data link - Improved navigation capabilities	- Automated arrival sequencing tools - Integration of ATC, Airports and Aircraft Operators planning processes	- Ground data communications infrastructure - Air/Ground data communications infrastructure	- A-SMGCS - Arrival management tools	
Departure management (runway sequencing and ground movement part)	2004: At isolated major airports (validation purpose)		- Air/Ground Data link	- DMAN tools	- Air/Ground data communications infrastructure	- Departure Manager Tools - A-SMGCS	
Integrated arrival & departure management	2008: Initial implementation at major airports		- Improved navigation capabilities - Air/Ground Datalink	- Integrated AMAN & DMAN tools - Integration of ATC, Airports and Aircraft Operators planning processes	- Air/Ground data communication infrastructure	- Integrated AMAN and DMAN Tools - A-SMGCS	

Improvements		Enablers					
Description	Date/ Area	Aircraft Operators		ATMO		Airport	Others
		AOC	Aircraft	ATM Systems	CNS		
Full Gate to Gate management of flight	2015	- CDM	- Improved navigation capabilities - Air/Ground Datalink	- Further integration with airports surface management, ATC, ATFM & AOCs - SMAN	- Air/Ground data communication infrastructure	- Further integration (airports surface management, ATC, ATFM & AOs) - A-SMGCS	
Safety nets							
Enhanced safety net capabilities	2000 - initial implement. at more advanced units		- ACAS II mandatory (by 2000) - GPWS - More accurate & dynamic surveillance data	- Safety nets (STCA/MSAW/APW)	- More accurate & dynamic surveillance data - Improvements in RDPS	- safety net tools	
Enhanced safety net capabilities (follow on)	2010 - in all units		- GPWS - More accurate & dynamic surveillance data	- Safety nets (STCA/MSAW/APW)	- More accurate & dynamic surveillance data - Improvements in RDPS	- safety net tools	
Improved Communications Efficiency							
Air/ Ground data link communication	2003 onwards		- Air/Ground Datalink	- CPDLC - Departure clearance & ATIS message applications - Initial contact & transfer of communications, etc. applications	- Air/Ground data communications infrastructure		
Separation responsibility transfer							
Initial separation responsibility transfer	2008		- ASAS (limited deployment) - ADS-B		- ADS-B		
Extended separation responsibility transfer	2015		- ASAS - ADS-B	- capabilities to support ASAS and to handle contingencies	- ADS-B		

Links with Benefits - En-Route and Terminal Air Traffic Control

Operational Improvement	Changes	Up to 2005			2005 to 2010			2010 to 2015		
		Capacity	Efficiency	Safety	Capacity	Efficiency	Safety	Capacity	Efficiency	Safety
Planning Tasks										
	Initial Automation of Routine Tasks	✓			✓					
	Enhanced Automation & Re-distribution of Control Tasks							✓		
Arrival and Departure Manager										
	Advanced Arrival Management	✓								
	Automated Arrival Sequencing				✓					
	Departure Management	✓								
	Integrated Arrival & Departure Management				✓					
	Full Gate to Gate Management of Flight								✓	
Safety Nets										
	Enhanced Safety Net Capabilities (more advanced units)			✓			✓			
	Enhanced Safety Net Capabilities (most units)									✓
Improved Communi-cations Efficiency										
	Pilot-Controller data link communication	✓			✓			✓		
Separation Transfer Responsibility										
	Limited Separation Responsibility Transfer					✓ In areas of low to medium traffic density				
	Extended Separation Responsibility Transfer								✓ In areas of low to medium traffic density	

Operational Improvements - Airports ATC



Airport Air Traffic Control

Improvements		Enablers					
Description	Date/ Area	Aircraft Operators		ATMO		Airport	Others
		AOC	Aircraft	ATM Systems	CNS		
Surface Movements							
Improvements of airport surface movements planning/routing, guidance and control	2002		- ADS-B - Cockpit HMI	- Initial A-SMGCS tools - Improved surveillance and conflict alert systems	- airport datalink systems - ADS-B	- Initial A-SMGCS tools - Improved surveillance systems - surface movement aids - airport data communications infrastructure	
A-SMGCS Surveillance & Alert functions	2004/2006 - at busier airports		- ADS-B	- Improved surveillance and conflict alert systems	- ADS-B	- A-SMGCS tools - Improved surveillance and conflict alert systems - ADS-B	
A-SMGCS surveillance, alert, planning/routing, guidance and control functions where necessary	2010 onwards		- ADS-B - Cockpit HMI	- Improved surveillance and conflict alert systems	- ADS-B	- Full A-SMGCS tools at busier airports - Some low cost A-SMGCS tools at medium and low capacity airports - Improved surveillance and conflict alert systems - ADS-B	
Integrated Airport Capacity Management with Collaborative Decision Making							
Runway & CFMU slot integration	2002 - At major airports 2005 - All ECAC airports	- CDM		- Information management support system - Enhanced FDPS	- Ground data communications infrastructure	- Information management support system - Ground data communications infrastructure	- EAD
Improved gate to gate management	2005	- CDM		- Information management support system	- Ground data communications infrastructure	- Information management support system - Ground data communications infrastructure	
Enhanced CFMU support for Schedule Co-ordinators	By 2008	- CDM		- Enhanced information management support system, full integrated systems (airport, en-route, ATFM)	- Ground data communications infrastructure	- Enhanced information management support system, full integrated systems (airport, en-route, ATFM) - Ground data communications infrastructure	
Optimised capacity management and best flight profiles, critical aircraft (hub & spokes operations) and critical situations monitoring, real time ATFM	By 2012	- CDM		- Enhanced information management support system, full integrated systems (airport, en-route, ATFM)		- Enhanced information management support system, full integrated systems (airport, en-route, ATFM)	

Improvements		Enablers					
Description	Date/ Area	Aircraft Operators		ATMO		Airport	Others
		AOC	Aircraft	ATM Systems	CNS		
Reduced Separation at Airports							
Initial Increase in airport capacity	2002/2005: At major airports	- CDM/ planning - Revised Surface Operations	- RNAV capability - Air/Ground data link - Precision landing aids - MMR	- AMAN/DMAN, enhanced FDPS		- DMAN, CADS, A-SMGCS tools, AMAN/DMAN - Precision landing aids - Improved visual cues for reduced runway occupancy	
Airports throughput increase (phase I)	2006/2008: At major airports	- CDM /planning - Revised Surface Operations	- Precision landing aids - RNAV capabilities - Air/Ground data link - Cockpit HMI - MMR - Windshear desectors	- AMAN/DMAN, enhanced FDPS	- GNSS/ EGNOS, airport surface aspects, datalink	- DMAN, CADS, A-SMGCS tools, AMAN/DMAN - Precision landing aids	- improved wind shear data and windshear detectors
Airports throughput increase (phase II)	2009/2012: At major airports	- CDM - Revised Surface Operations /planning	- Precision landing aids - RNAV capabilities - Air/Ground data link - Cockpit HMI - MMR - Wake vortex and windshear desectors	- AMAN/DMAN, Enhanced FDPS	- GNSS/ EGNOS , airport surface aspects, datalink	- DMAN, CADS, A-SMGCS tools, AMAN/DMAN - Precision landing aids	- Wake vortex and wind-shear detectors
All weather operations							
Local weather measurements	2002				- AirGround communications infrastrucutre	- Optimised airport Met. system for local weather measurement	
Improved runway all weather operations	2008		- MMR	- A-SMGCS integrated with AMAN & DMAN	- GNSS/ EGNOS, airport surface aspects	- A-SMGCS integrated with AMAN & DMAN	
Improved runway and surface management for all weather operations	By 2008 : At major airports By 2012: At all airports		- Precision landing aids, satellite navigation - Cockpit HMI - MMR		- GNSS/EGNOS, airport surface aspects	- Precision landing aids, satellite navigation	

Links with Benefits - Airport Air Traffic Control

Operational Improvement	Changes	Up to 2005			2005 to 2010			2010 to 2015		
		Capacity	Efficiency	Safety	Capacity	Efficiency	Safety	Capacity	Efficiency	Safety
Surface Movement										
	Improvement of Surface Movements planning/routing, etc.	✓	✓							
	A-SMGCS Surveillance & Alert						✓			
	A-SMGCS Surveillance, Alert, Planning/ Routing, Guidance & Control							✓		
Integrated Capacity Management & Collaborative Decision Making										
	Runway and CFMU slot integration	✓								
	Improved Gate to Gate Management					✓				
	Enhanced CFMU support for schedule co-ordinators				✓					
	Optimised Capacity Management & Real-time ATFM / Schedule co-ordination							✓	✓	
Reduced Separation										
	Initial Increase in Airports Capacity	✓								
	Airports Throughput Increase (Phase I)				✓					
	Airports Throughput Increase (Phase II)							✓		

Operational Improvement	Changes	Up to 2005			2005 to 2010			2010 to 2015		
		Capacity	Efficiency	Safety	Capacity	Efficiency	Safety	Capacity	Efficiency	Safety
All Weather Operations										
	Local Weather Measurement									
	Improved Runway All Weather Operations				✓					
	Improved Runway & Surface Management all Weather Operations				✓			✓		

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Appendix 3 : Changing Roles and Responsibilities

NOTE: Roles and responsibilities are far more extended and complex than indicated below. This appendix aims to highlight some of the key evolutions through time and is intended to focus attention on the humans responsible for flight and ATM operations on a daily basis. The main changes which take place in each period are highlighted in italics.

The description has been restricted deliberately to those actors directly connected with flight operations. A more comprehensive picture would also need to address other actors (e.g: technical staff) who will also be affected by the introduction of new systems.

Period	Pilot	Controller	Aircraft Operators
Up to 2005	**responsible for:** • conduct of flight and instigating changes to plan; **in an environment with:** • navigation based RNAV systems; • greater choice of flight trajectory available on free routes in upper airspace for suitably equipped aircraft; • RT used as main communications with controller and initial/air ground data link applications; • improved cockpit HMI with some automated inputs into FMS.	**responsible for:** • separating aircraft; • a defined fixed airspace sector; **in an environment with:** • a largely unchanged control team; • some tasks (co-ordination & transfer automated); • RT as main communications means with pilot, but initial air/ground data link applications; • electronic flight strips in many units. • Increasing reliance on computer tools for monitoring and alerting; • growing emphasis on de-confliction planning; • arrival manager for sequencing aircraft at major airports.	**responsible for:** • pre-planning of flights; **in an environment with:** • some automated links with CFMU, Met. and AIS; • more choice on re-routings; • early CDM operations.
Up to 2010	**responsible for:** • conduct of flight and negotiating changes to trajectory with the ground controller, in some instances in conjunction with Aircraft Operations Centre (AOC); • separation in some defined circumstances (climb, same-way routes) in suitably equipped aircraft;	**responsible for:** • separating aircraft except in limited and defined circumstances; • defined airspace sector but boundaries are subject to change to reflect traffic patterns;	**responsible for:** • pre-planning of flights and diversions; **involved in:** • route choices and in-flight trajectory changes; • some operators: direct negotiation with ATC and aircraft on dynamic route and timings changes.

Period	Pilot	Controller	Aircraft Operators
(…) Up to 2010	**in an environment with:** • less reliance on RT and many routine messages are exchanged via data link; • greater reliance on 4D flight trajectories and navigation techniques using satellite systems; • integrated FMS with route change inputs automated on many aircraft; • early introduction of ASAS capabilities with improved situational awareness displays on some aircraft; • greater reliance on cockpit systems for airport surface movement.	**in an environment with:** • progressive emphasis on planning rather than tactical intervention • less reliance on RT and many routine messages exchanged via data link; • most inter-unit data exchange automated, and electronic flight strips at most ATC units; • growing reliance on planning tools and computer generated resolution advice; • controller relying on automated slot sequencing for arrivals and departures at most major airports.	**in an environment with:** • automated links with CFMU, AIS, Met. ATC and airports.
Up to 2015	**responsible for:** • conduct of flight and negotiating changes to trajectory in conjunction with AOC; • maintaining own separation in designated free route airspace using ASAS; **in an environment with:** • routine messages passed by data link with much reduced use of RT; • most trajectory monitoring and change automated within FMS; • automated systems used for airport surface movement.	**responsible for:** • separating aircraft in managed airspace; • managing the organisation of traffic to ensure a smooth flow, particularly in border areas between free and managed airspace; **in an environment with:** • emphasis on automated medium-term planning over a number of sectors and monitoring of de-conflicted trajectories; • routine messages passed by data link with much reduced use of RT; • controller relying on automated slot sequencing for arrivals and departures at major airports.	**responsible for:** • pre-planning of flights and diversions; **involved in:** • direct negotiation with ATC and aircraft on dynamic route and timing changes; • changes to aircraft landing and take-off times negotiated directly with ATC, CFMU and airports. **in an environment with:** • automated down-linking of flight parameters from aircraft in-flight and dynamic optimisation of trajectories passed directly to aircraft.

Appendix 4 : List of Possible Economic Studies

List of possible Economic Studies

The measures set out in the ATM Strategy for 2000+ should be supported by a new approach to the economic and financial framework for ATM. This will require investigation, studies and economic modelling to ascertain the effects of various economic measures, and to determine which provide the most effective and practical path to realising the economic objectives to reduce the ATM-related costs, while maintaining conditions for fair competition (a level playing-field) between the ATC providers.

A list of proposed topics for studies within the economic frameworks set out in Section 4.3 is given below. The list is not exhaustive, and indicates potential areas of study which might prove useful. Also, other complementary topics may be identified as further information becomes available. Additionally, the results of such studies would need to be considered further, and inclusion of the list does not imply that States or other stakeholders would, or should, adopt or apply the results obtained from such studies.

All studies should identify the impact on different stakeholders, including military aviation.

Performance Measurement

- performance measurement (already initiated by the PRC).

Economic Regulation

- possible economic regulation models, to provide clear principles for service providers.
- the economic advantages and implications of the separation of regulatory function from the service provision function.

Service Levels Policy

- the possibility of, and conditions for, certifying providers to offer services.
- a proposed model for cross-border agreement for facility sharing.
- conditions for successful common management of facilities

Business Risk and Reward

- cost-recovery and pricing instruments to provide incentives for ATM service providers.

Pricing Policy

- using pricing as a tool to help solve capacity problems and manage congestion.
- common accounting codes to identify present & future costs of airport and airspace services.

Co-ordination of Use of Resources

- high-level overview of costs and benefits of the programmes and projects resulting from the application of the Strategy.
- suitability of regional systems to assist in the rationalisation of ground based infrastructure.

Facilitating Financing of Investments

- investment funds available.
- means to apply synergy to common investment policies.
- a manual of good practice on financing for ATM facilities and services.

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